Medium and long run prospects for UK growth in the aftermath of the financial crisis*

Nicholas Oulton§

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§Corresponding author: Nicholas Oulton, address: Centre for Economic Performance, London School of Economics, Houghton Street, London WC2A 2AE, United Kingdom, email: n.oulton@lse.ac.uk.

Abstract

In this paper I argue that the financial crisis is likely to have a long term impact on the *level* of labour productivity in the UK while leaving the long run *growth rate* unaffected. Based entirely on pre-crisis data, and using a two-sector growth model, I project the future growth rate of GDP per hour in the market sector to be 2.61% p.a. Based on a cross-country panel analysis of 61 countries over 1950-2010, the permanent reduction in the level of GDP per worker resulting from the crisis could be substantial, about 5½%. The cross-country evidence also suggests that there are permanent effects on employment, implying a possibly even larger hit to the level of GDP per capita of about 9%.

JEL classification codes: J24, E32, O41, G01, H63
Key words: productivity, potential output, growth, financial, banking crisis, recession

1 Introduction

The UK economy went into recession in 2008Q2. GDP fell in that quarter and continued falling for the next five quarters. It stopped falling in 2009Q3 and began growing again but so slowly that in 2013Q1 its level was still 4% below the previous peak in 2008Q1 (see Chart 4 Table 1).[1] The fall in GDP per capita has obviously been even larger since the population has continued to grow. The whole period since 2008Q1 therefore justifies the term "slump" or even "depression". Few if any commentators expected a slump of this severity because few foresaw the financial crisis. After it became apparent that the recession, though deep, was over many expected the recovery to be equally rapid. But this didn't happen. The recovery has been slow and is still incomplete. There have been many surprising features of the five or so years since the recession began. First, despite the massive fall in output, unemployment rose comparatively modestly from 5.2% in 2008Q1 to a high of 8.4%; it is currently 7.8%. Second, employment and total hours worked, after falling initially, have been robust: employment and hours are both now higher than at the peak (Charts 6 and 7). The flip side of these facts is the productivity puzzle: not only has labour productivity (whether measured on an hours basis or a heads basis) stopped growing, its level has actually fallen. In 2013Q1 GDP per hour worked was still 5% below its peak level (Chart 5). All this calls into question the future prospects of the UK economy which seemed so bright during the boom. Was it all just an illusion? This is the question on which I hope this paper will throw some light.

In 1995 I published an article with the somewhat sceptical title "Supply side reform and UK economic growth: what happened to the miracle?" (Oulton, 1995).[2] I argued that up till the end of the 1970s the growth of the British economy had been hampered by two factors: first, our dysfunctional system of industrial relations and second a low level of investment in human capital. Despite the title, my conclusion was upbeat. The Thatcher reforms of the 1980s (reduction of union power coupled with privatisation of state-owned industries), which have been maintained and extended by subsequent governments, together with increased

[1] A year ago, the ONS had the recession ending in 2009Q2, but they have revised their view since then. 2013Q1 is the latest quarter for which national accounts data were available at the time of writing.

[2] Younger readers may like to note that "miracle" was a term attached by some commentators in the 1980s to the improvement in productivity growth observed then, particularly in manufacturing.

investment in education, particularly higher education,[3] and improvements in primary and secondary education, had greatly improved British prospects. So I expected more rapid growth would follow and indeed was already apparent. But there was an important caveat. UK performance had also been set back by poor macro policies which led to unnecessarily prolonged recessions. Optimistically, I thought these could be avoided in the future (provided we did not join the euro). At the time, mine was not a popular conclusion, at least in academic circles. A conclusion more in line with (then) received academic wisdom can be found in an article published two years after mine:

> "While legal intervention has had an impact on the institutions of industrial relations, most notably in reducing the power of organised labour, this cannot be isolated from wider structural changes in labour and product markets. A review of research on economic outcomes suggests an uneven and tenuous link between institutional change and economic performance" (Brown *et al*., 1997).

However, since these articles were published evidence has accumulated that the UK's performance did indeed improve and growth was faster than in most comparable countries. Now the LSE Growth Commission (2013) has set its seal of approval on the view that the reforms begun under the Thatcher governments were highly effective in raising UK growth:

> "Despite the current gloom, the UK has many assets that can be mobilised to its advantage, including strong rule of law, generally competitive product markets, flexible labour markets, a world-class university system and strengths in many key sectors, with cuttingedge [sic] firms in both manufacturing and services. These and other assets helped to reverse the UK's relative economic decline over the century before 1980. Over the course of the following three decades, they supported faster growth per capita than in the UK's main comparator countries – France, Germany and the US."[4]

Perhaps the clearest way to see this is to look at the growth of GDP per hour worked in the market sector (thus avoiding incompatibilities in the way public sector output is measured in different countries). In Charts 1 and 2 I compare 16 countries over two periods, 1970-1990

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[3] The proportion of people aged 25-34 in Britain who have a university degree is approaching 50% and is the 6th highest in the OECD. This proportion is now higher in the UK than in the United States while the proportion aged 25-64 with a degree is close behind the US one (OECD 2013).

[4] See too Van Reenen (2013) who also credits the reforms begun in the Thatcher era.

and 1990-2007, using the EU KLEMS database (O'Mahony and Timmer 2009). In the first period GDP per hour grew at 1.89% p.a. in the UK, the fourth slowest in this group of countries, behind France, Germany Italy and Japan amongst others, though slightly ahead of the US. In the second period it grew at 2.87% p.a., ahead of all the above countries and behind only Ireland, Finland and Sweden.

But all this optimistic evidence has been called into question by the world-wide financial crisis which has led (it hardly needs arguing) to the worst recession in the UK since the 1930s.[5] Figure 1 sets out in schematic form three possible scenarios for the future after a crisis-induced recession, labelled "optimistic", "pessimistic" and "very pessimistic". Here the dashed lines represent trend (potential) GDP per hour, based on pre-crisis conditions. Under the "optimistic" scenario the economy recovers, the original trend growth rate prevails again (possibly after a lengthy period) and furthermore the *level* of GDP per hour eventually returns to the value it would have achieved if the crisis had somehow been avoided. In other words the economy eventually returns to the track (the dashed line) it would have been predicted to be on in the absence of the crisis. Of course, even under this scenario the crisis has not been costless since there has been a permanent loss of output relative to potential during the recession and recovery. But after a bit this is just a bygone. Under the "pessimistic" scenario, the economy eventually regains its trend growth rate but it never gets back on the original track: GDP per hour is always below what it would have been without the crisis. (It has become something of a commonplace to say that the recovery from a financial crisis tends to be long and slow. But this statement might describe either the pessimistic or the optimistic scenario, because it does not distinguish clearly between levels and growth rate effects). Finally, under the "very pessimistic" scenario, not only does the economy never get back on the original track but it falls progressively further and further below it. In other words the trend growth rate has fallen as a result of the crisis.[6]

Which of these scenarios is closer to the truth for the UK? My argument in this paper is that the pessimistic scenario is the most likely: the UK will eventually regain its previous

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[5] This may be unfair to the 1930s which saw a private house-building boom and imaginative infrastructure projects like electrification and the National Grid. The main reason the 1930s have such a bad image is the high rate of unemployment.

[6] For reasons of symmetry one might want to add a fourth scenario, "very optimistic", under which the trend growth rate is *raised* by the crisis due to the "cleansing" effect of the recession. But there has never been much evidence for the empirical importance of cleansing and it certainly seems absent from the current slump. To the contrary some argue that the dysfunctional banking system is preventing normal cleansing from taking place: see the discussion below on zombie firms.

trend growth rate but will have suffered a permanent loss in GDP. The main reason for this conclusion is that it is what we would expect as a result of a banking crisis. This argument is not advanced with 100% confidence and clearly much depends on external conditions over which we in the UK have no control. And it also depends on a continuation of reasonably good policies, particularly with regard to government debt, as discussed later.

Plan of the paper

I start in Section 2 by setting out a framework for estimating long run growth, based on a neo-classical two-sector model. I argue that two sectors are necessary to take proper account of the impact of information and communication technology (ICT), which is of continuing importance in my view. I use this model to develop a projection for the long run growth rate of labour productivity (output per hour) in the UK market sector. This projection takes no account of the financial crisis and is calibrated entirely on pre-crisis data. It shows if you like what might have happened (on reasonable assumptions) had the financial crisis somehow been avoided: it corresponds to the dashed lines in Figure 1. Next in section 3 I look at what has actually happened to the British economy since the boom came to an end in early 2008. As we all know there has been not just a decline in the productivity growth rate but an actual fall in the level of productivity from its peak which has yet to be regained. I consider various hypotheses that have been advanced to explain the productivity puzzle, including GDP mis-measurement, declining human and physical capital intensity, labour hoarding and zombie firms. Since this is such a contested topic, I devote Section 4 to considering the impact of austerity. In Section 5 I look at international evidence on the effects of banking crises on output per worker, capital per worker, total factor productivity (TFP), and output per capita, via a panel data study of 61 countries over 1950-2010. This enables one to quantify the permanent loss of GDP that is due to the crisis. However this model does not enable one to distinguish between the pessimistic and the very pessimistic scenarios (since the pessimistic scenario is the maintained hypothesis). I therefore turn in Section 6 to consider two case studies: the US in the aftermath of the Great Depression of the 1930s and Japan after the bubble burst in 1990 when it entered on its so-called “lost decade(s)”. As we shall see the US supports the case for the “pessimistic” scenario while Japan supports the case for the “very pessimistic” one. Section 7 concludes.

2 A pre-crisis projection of UK productivity growth[7]

In this section I first make the general case for explicit consideration of ICT in making projections of future growth. Then I discuss the basic neo-classical (Solow) growth model and why it is deficient when ICT is important. I next set out a two-sector model in which the second sector produces ICT investment goods. Technical progress is assumed to be more rapid in the ICT sector. Finally I calibrate this model using pre-crisis data only.

2.1 The importance of ICT

The approach adopted here recognises the central importance of ICT in the modern world. After the growth rate of US labour productivity started to rise in the latter half of the 1990s, a number of highly influential growth accounting studies were published. These included Oliner and Sichel (2000) and (2002), Jorgenson and Stiroh (2000a) and (2000b), Stiroh (2002), and Jorgenson, Ho and Stiroh (2004a, 2004b and 2007). These studies all attributed a high proportion of the productivity resurgence to ICT, and found that most of the improvement was due to the *use* of ICT equipment by other industries (capital deepening) rather than to the *production* of ICT equipment by the ICT industries themselves. Similar studies have been published for the UK (Oulton 2002); Oulton and Srinivasan 2005; Marrano *et al*. (2009)), and for the G7 (Schreyer 2000); a US-UK comparison is Basu *et al.* (2004) and an EU-US comparison is van Ark, O'Mahony and Timmer (2008). These all find a very important role for ICT capital deepening in accounting for the growth of productivity in the different countries. It is true that some observers questioned the growth accounting methodology and remained sceptical of the true importance of ICT, especially in the light of the dotcom bust of 2000 and the subsequent US recession. But the fact that US productivity growth continued to be rapid in the first decade of the present century and that ICT investment recovered to reach levels substantially higher than at the height of the dotcom boom has convinced most observers, including even initial sceptics (see e.g. Gordon (2003)) that investment in ICT is a very important part of the story, at least as a proximate cause (Oliner *et al*. (2007)). The conclusions of growth accounting were anticipated to some extent

[7] This section draws heavily on Oulton (2010) and (2012) where more detailed justification for some of the methods and assumptions can be found.

by earlier micro-based studies (e.g. Lichtenberg (1995); Brynjolfsson and Hitt (1995)) and confirmed by later ones: see e.g. Brynjolfsson *et al.* (2002), Brynjolfsson and Hitt (2003), Bloom *et al*. (2007), and Draca *et al.* (2006).

By their nature academic studies are always somewhat out of date, at least when they come to be published. So some more recent data is worth noting. Those who think that the ICT boom of the late 1990s was all irrational exuberance, a product of dotcom fever and Y2K hysteria, might like to note that in the US the net stock of computers was 109% higher in 2007 than it had been in 2000, while the net stocks of software and communications equipment were 53% and 45% higher respectively (source: Bureau of Economic Analysis, Fixed Asset Tables, Table 2.2, available at www.bea.gov). The increase in the stock of communications equipment is particularly noteworthy given that many observers thought that the end of the dotcom boom left the US with considerable surplus capacity in fibre optic cables. So growth has been substantial even if at a slower rate than in the 1990s.

It is also useful to consider ICT in historical context: how does it compare with the great inventions of the past (Gordon 2000)? ICT is now frequently regarded as a general purpose technology or GPT (Lipsey *et al*. 2005). Earlier examples of GPTs are steam technology and electricity (David 1990)). Steam technology is usually considered central to the Industrial Revolution. But Crafts (2004) argues that the impact of ICT on labour productivity in the modern era has been greater than that of steam in the 19th century. The main reason is that the rate of decline of steam's relative price, due to faster technical progress in steam engines than in the rest of the economy, was quite modest for much of the nineteenth century.

2.2 The textbook one–sector model

I start with the textbook, one-sector (Solow) model, augmented to include human capital. Consideration of this model will motivate the move to a two-sector model. Here we assume just one sector whose output can be used for either consumption or investment. For simplicity and for consistency with the two-sector model below, I assume that the production function is Cobb-Douglas with constant returns. The equations of the model are:

$$Y = C + I = BK^{\gamma}[hH]^{1-\gamma}, \quad 0 < \gamma < 1 \tag{1}$$

and

$$\dot{K} = I - \delta K \tag{2}$$

where Y is output, C is consumption I is investment, B is the level of total factor productivity (TFP), H is hours worked, h is the average level of skill (human capital) per worker, and δ is the geometric rate of decay (depreciation) of capital. Output per hour (y) is

$$y = \frac{Y}{H} = Bh^{1-\gamma}k^{\gamma} \tag{3}$$

putting $k = K / H$. TFP is assumed to grow at the exogenous rate μ, hours worked (H) at the exogenous rate n, and human capital (skill) at the exogenous rate g_h.

As is well-known, under standard assumptions this model possesses a steady state in which output per hour grows at a constant rate given by:

$$\hat{y}^* = \frac{\mu}{1-\gamma} + g_h \tag{4}$$

where a "hat" (^) denotes a growth rate and a star (*) denotes the steady state. In the basic Solow model there is only one engine of growth, the exogenous growth of TFP (μ). Here there is also a second engine, the growth of human capital (g_h). Physical capital plays an important role, but in the long run all capital deepening (growth of k) is induced by growth of TFP or growth of skill.[8]

In this model, forecasting the long run growth rate of hourly labour productivity (y) is fairly straightforward: it requires just a forecast of TFP growth (μ), an estimate of the parameter γ which corresponds to the capital share, and an estimate of the growth rate of skill (h). Assuming that inputs are paid their marginal products, TFP growth can be measured by

$$\mu = \hat{B} = \frac{\dot{Y}}{Y} - v_K\left(\frac{\dot{K}}{K}\right) - v_L\left(\frac{\dot{H}}{H}\right) - v_L\hat{h} \tag{5}$$

where $v_K(v_L)$ is the income share of capital (labour) and $v_K + v_L = 1$. (In terms of the model, $v_K = \gamma,\ v_L = 1-\gamma$). A forecast of TFP growth can be based on its own history, which empirically could be measured using a discrete-time Törnqvist index:

$$\ln\left[\frac{B_t}{B_{t-1}}\right] = \ln\left[\frac{Y_t}{Y_{t-1}}\right] - \bar{v}_{K,t}\ln\left[\frac{K_t}{K_{t-1}}\right] - \bar{v}_{L,t}\ln\left[\frac{H_t}{H_{t-1}}\right] - \bar{v}_{L,t}\ln\left[\frac{h_t}{h_{t-1}}\right] \tag{6}$$

[8] The derivation assumes a Cobb-Douglas production function but this is only for comparability with what follows. Essentially the same results could be derived from any neo-classical production function with purely labour-augmenting technical progress.

where $\bar{v}_{K,t} = \frac{1}{2}\left[v_{K,t} + v_{K,t-1}\right]$ and $\bar{v}_{L,t} = \frac{1}{2}\left[v_{L,t} + v_{L,t-1}\right]$ .Similarly, a forecast of the growth of skill could be based on its own past history.[9]

I have calibrated the one-sector model on UK data over the period 1979-2003. I find that the model under-predicts the actual growth rate experienced over this period and that the discrepancy grows over time. This is the case whether or not we assume that the UK economy was in a steady state over this period: see Annex B of Oulton (2010).

But there is a more fundamental reason why the one-sector model is inappropriate for an era when ICT is very important. Where does ICT appear in the solution for the equilibrium growth rate, equation (4)? If we applied the model to an economy with some ICT production, then the fact that TFP growth has been (and will probably continue to be) higher in ICT than in non-ICT industries will influence the past and projected future aggregate TFP growth rate. But suppose instead we are considering a small, open economy with no ICT production at all (not an unrealistic assumption). Then the one-sector model predicts zero impact from the ICT revolution. But surely the ability to import ICT capital at ever-declining prices must be beneficial to growth? As we are about to see, this is exactly what the two-sector model predicts.

2.3 A two–sector model[10]

The one-sector model assumes in effect that there are no persistent changes in the relative prices of the myriad goods which make up a real economy. It thus fails to capture the most

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[9] The growth of skill can be measured by the difference between a quality-adjusted index of the growth of hours and the unadjusted growth of hours. In the quality-adjusted index each type of labour is weighted by its wage. So quality is rising if the composition of the labour force is shifting towards more highly paid forms of work. For UK measures of skill growth, see Bell *et al*. (2005); similar measures appear in the EU KLEMS database. The ONS also now produces a similar measure.

[10] The present model draws on Oulton (2007). A model similar in structure to the present one but with a quite different interpretation is in Barro and Sala-i-Martin (1995), chapter 5. The two-sector model with faster technical progress in investment goods was revived by Whelan (2001) and applied by Martin (2001) to study the US economy and by Cette *et al.* (2005) to compare France and the US It was also employed by Bakhshi and Larsen (2005) to analyse the impact of macroeconomic shocks in the UK context. Oliner and Sichel (2002) employ the steady state of a five-sector model for some of their projections of the US economy. For earlier work on two-sector models with discussion of stability issues (not treated here), see Burmeister and Dobell (1970). The main difference between the earlier work and the present application is the extension of the two-sector model to an open economy.

striking feature of recent economic history in the industrialised economies, namely the dramatic and persistent falls in the relative price of ICT investment goods. For example, in the United States between 1970 and 2007 the relative price of computers in terms of the price of output in the non-farm business sector was falling at an average rate of 20.32% per year; the relative price of the broader category of "information processing equipment and software" was falling at 8.12% per year (source: U.S. National Income and Product Accounts (NIPA); see Chart 3). This rate of decline, sustained over four decades and more, is unprecedented. So I now consider a two-sector model in which the relative price of the good produced by the second sector is changing.

I assume that the output of the first sector can be used either for consumption (C) or for investment (I_C); the output of the second sector, which we can think of as the sector producing ICT goods, can only be used for investment (I_{ICT}). For brevity, I refer to the sector producing consumption and non-ICT investment goods as just the consumption sector. The production function for this sector is given by

$$Y_C = B_C\left(K_C^C\right)^{\alpha}\left(K_{ICT}^C\right)^{\beta}\left(hH_C\right)^{1-\alpha-\beta}, \quad 0<\alpha,\beta<1,\ \alpha+\beta<1 \tag{7}$$

where K_C^C, K_{ICT}^C are capital services of non-ICT and ICT capital respectively that are used by the consumption sector (here the superscript represents the industry), and H_C is hours worked in that sector. In per hour terms,

$$y_C = \frac{Y_C}{H_C} = B_C h^{1-\alpha-\beta}\left(k_C^C\right)^{\alpha}\left(k_{ICT}^C\right)^{\beta} \tag{8}$$

Here $k_C^C = \frac{K_C^C}{H_c}$ and $k_{ICT}^C = \frac{K_{ICT}^C}{H_c}$, the capital intensities in the consumption sector. I assume as before that skill is growing exogenously at rate g_h and that TFP in the consumption good sector (B_C) is growing at rate μ_C.

For the ICT-producing sector, I make a crucial, simplifying assumption: the production function is the same as in the consumption sector, except for TFP. As a result, in equilibrium the capital intensities will be the same in both sectors and equal to the whole-economy input endowments. The production function for the ICT sector is:

$$y_{ICT} = \frac{Y_{ICT}}{H_{ICT}} = B_{ICT} h^{1-\alpha-\beta}\left(k_C^{ICT}\right)^{\alpha}\left(k_{ICT}^{ICT}\right)^{\beta} \tag{9}$$

Here $k_C^{ICT} = \frac{K_C^{ICT}}{H_{ICT}}$ and $k_{ICT}^{ICT} = \frac{K_{ICT}^{ICT}}{H_{ICT}}$, the capital intensities. The growth rate of TFP in the ICT sector, $\mu_{ICT} = \hat{B}_{ICT}$, is assumed exogenous. I also assume that $\mu_C < \mu_{ICT}$.

Next, input supplies must equal demands:

$$K_C = K_C^C + K_C^{ICT} \tag{10}$$

$$K_{ICT} = K_{ICT}^C + K_{ICT}^{ICT} \tag{11}$$

$$H = H_C + H_{ICT} \tag{12}$$

The accumulation equations, where I denotes investment and where δ_C, δ_{ICT} are the geometric rates of depreciation, are:

$$\dot{K}_C = I_C - \delta_C K_C \tag{13}$$

$$\dot{K}_{ICT} = I_{ICT} - \delta_{ICT} K_{ICT} \tag{14}$$

There are also balance equations which state that the supply (domestic output plus imports) of each industry's output must equal demand (home plus foreign). It is also useful to define the price of ICT goods relative to that of consumption goods, p: $p = P_{ICT} / P_C$ where P_{ICT}, P_C are the nominal prices of the ICT and consumer goods respectively.

Oulton (2012) shows that the model possesses a steady state (defined as a state where the real interest rate and the proportion of aggregate hours allocated to each sector are constant) with the following properties. The growth rate of consumption per hour worked ($c = C / H$) is constant in the steady state:

$$\hat{c}^* = \frac{(1-\beta)\mu_C + \beta\mu_{ICT}}{(1-\alpha-\beta)} + g_h \tag{15}$$

It can also be shown that

$$\hat{p} = \mu_C - \mu_{ICT} < 0 \tag{16}$$

since by assumption $\mu_C < \mu_{ICT}$. So the steady state growth rate can also be written as:

$$\hat{c}^* = \frac{\mu_C - \beta\hat{p}}{(1-\alpha-\beta)} + g_h \tag{17}$$

This second form of the solution is useful in the empirical work.

To complete the solution of the model, the steady state growth rates of output per hour in the two sectors are:

$$\hat{y}^*_C = \hat{c}^*$$

$$y^*_{ICT} = \hat{c}^* - (\mu_C - \mu_{ICT}) = \hat{c}^* - \hat{p} > \hat{y}^*_C \tag{18}$$

Note that in steady state:

(1) Output and productivity of the consumption good grow less rapidly than does output and productivity of the ICT good.

(2) The stock of ICT capital grows faster than the stock of non-ICT capital.

(3) The ratios of investment to GDP, the capital-output ratios and the savings ratio, all in value (current price) terms, are constant in the steady state.

Intuitively, where there were two engines of growth in the one-sector model, TFP and skills growth, there is now a third, TFP growth in the ICT sector which is faster than in the consumption sector. This third engine drives up the growth rate of consumption permanently.

A Divisia index of the steady state growth rate of real GDP per hour (*y*) can now be derived as:

$$\hat{y}^* = \frac{\mu_C - \left[\beta + (1-\alpha-\beta)\, w^*_{ICT}\right]\hat{p}}{(1-\alpha-\beta)} + g_h \tag{19}$$

where $w^*_{ICT} = pY^*_{ICT} / (Y^*_C + pY^*_{ICT})$ is the steady state output share of the ICT sector. The growth rate of GDP per hour is obviously positively related to the two TFP growth rates. It is also positively related to (a) the income share of ICT capital (β) and (b) the share of ICT output in GDP (w^*_{ICT}). It is easy to see that real GDP grows more rapidly than real consumption in the steady state if the ICT output share is greater than zero (i.e. if $w^*_{ICT} > 0$). Note that the solution to the two-sector model, equation (19), reduces to that of the one-sector model, equation (4), if $\hat{p} = 0$, i.e. if TFP growth is the same in both sectors (and noting that in this case $\alpha + \beta = \gamma$).

The solution just given applies just as much to an open as to a closed economy. It shows how misleading the one-sector model can be. For that model predicts that the long run growth rate of a small economy which is completely specialised in the non-ICT good is determined entirely by TFP growth in that sector (and the labour share). So such an economy apparently derives no benefit at all from the ICT revolution. But we now see that it does benefit in the form of improving terms of trade and the two-sector model allows us to quantify this effect.

If the ICT output share is zero ($w^{*}_{ICT} = 0$), then the boost to growth coming from the fact that technical progress is faster in ICT is $-\beta\hat{p}/(1-\alpha-\beta) > 0$.

2.4 Implementing the two-sector model empirically

The empirical counterpart of the theoretical equation (19), describing the steady state growth of GDP per hour, can be written as follows:

$$\Delta \ln \bar{y} = \frac{\Delta \ln \bar{B}_C - \left[\bar{v}_{K_{ICT}} + \bar{v}_L \bar{w}_{ICT}\right]\Delta \ln \bar{p}}{\bar{v}_L} + \bar{g}_h \qquad (20)$$

where bars over variables indicate projected values; $\bar{v}_{K_{ICT}}$ is the projected income share of ICT capital, $\bar{v}_L$ is the projected income share of labour, $\bar{w}_{ICT}$ is the projected output share of the ICT sector, and $\bar{g}_H$ is the projected growth rate of hours worked. Values for these parameters are required for medium/long run projections of GDP growth.

Annual data for the UK for the income and output shares of ICT, the labour share, the growth of skill, and overall TFP growth[11] can be found in the EU KLEMS database, for the years 1970-2007. The growth rate of the relative price of ICT is taken from the US NIPA. Most researchers who study the impact of ICT consider the US price indices to be more reliable than their counterparts in other countries (Schreyer (2002), Oulton (2001); O'Mahony and van Ark (2003); Oulton and Srinivasan (2005)).[12] I follow suit here and measure the relative price of ICT as the US price of ICT equipment (computers, software and communications equipment) relative to the price of gross value added in the non-farm business sector (the latter being close to the EU KLEMS market sector).

All these series (in log levels for TFP and the ICT relative price, in levels for the shares) are passed through a Hodrick-Prescott filter. I have used two methods to pick parameter values, depending on the nature of the time series. In the case of series which appear stationary like the labour share I use the mean over 1990-2007. In other cases I use the value of the HP trend of that variable (or its growth rate) in 2007. The parameter values I adopted

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11 Given an estimate of overall TFP growth, say $\Delta \ln \bar{B}$, we can apply Domar aggregation to obtain $\Delta \ln \bar{B}_C = \Delta \ln \bar{B} + \bar{w}_{ICT} \Delta \ln \bar{p}$.

12 In the UK the Office for National Statistics now employs a similar methodology to that of the U.S. Bureau of Economic Analysis to measure the price of computers, but this new methodology has only been applied to recent years of the computer price series. So the UK series moves in a similar way to the US one in recent but not in earlier years.

are in Table 2. The value for $\Delta \ln \bar{p}$, the projected rate of decline of the ICT relative price, is quite a conservative one. It is (numerically) smaller than its mean value over 1990-2007 (minus 8.12%) since the HP trend picks up an apparent deceleration after 2000 (Chart 3). Plugging the parameter values in the table into equation (20), the growth rate of the UK's GDP per hour in the market sector is projected to be 0.0261 or 2.61% p.a. The extra boost to growth coming from the falling price of ICT is estimated as

$$\frac{-\bar{v}_{K_{ICT}} \Delta \ln \bar{p}}{\bar{v}_L} = 0.0052 \qquad (21)$$

or 0.52% p.a., i.e. about a fifth of future growth is projected to come from the falling price of ICT. The projected growth rate is slower than the rate actually achieved over 1990-2007, 2.87% (see Chart 2) mainly because of the assumption that ICT prices will fall more slowly in future. If to the contrary they continue to fall at the average rate actually observed over 1990-2007 (8.12% p.a.) then the projected growth rate would rise to 2.79% p.a. with the ICT contribution rising to 0.71% p.a.

It is also worth noting that the projected growth rate generated by the one-sector model is much lower. The mean TFP growth rate in the UK market sector was 1.14% p.a. over 1990-2007. Applying equation (4) generates a projected growth rate of only 2.13%. This is much slower than the actual rate experienced over 1990-2007 (2.87% p.a.). Recall that all these calculations are based on pre-crisis data.

ICT has been an important source of growth for the UK since the UK has been an early adopter of the new technologies. Out of 19 leading economies the ICT income share was higher in the UK than in 15 of the others, being surpassed only by the US and the Swedish shares (Oulton 2012). Cette and Lopez (2008) found that across countries the ICT income share varies positively with the extent of higher education and negatively with product and labour market rigidities. It is likely therefore that the high UK share reflects our advantages on these dimensions.

3 Labour productivity during and after the Great Recession: puzzles and explanations

This section reviews the course of labour productivity in the United Kingdom in and after the Great Recession. I consider first some puzzling facts and then turn to possible explanations.

3.1 Puzzles

Chart 5 shows the course of quarterly labour productivity (GDP per hour worked) from 1997Q1 up till the latest date available at the time of writing, 2013Q1. This chart and succeeding ones have a common format. What actually happened (according to the most recent information) is shown as a solid line with a dashed line showing the trend estimated over the pre-recession period. The trend is calculated by the Hodrick-Prescott (HP) filter (with parameter set to 1600 since these are quarterly data) over the pre-crisis period 1997Q1-2008Q1 and extrapolated beyond then to the end of the period (2013Q1). The HP trend should not be taken too literally: it should not necessarily be interpreted as a forecast of what would have happened if the recession could somehow have been avoided. The charts also show the Great Recession (the period of falling GDP, 2008Q2-2009Q3) marked by a red bar.

GDP started falling in 2008Q2 and continued falling in the subsequent five quarters up to and including 2009Q3 (Table 1).[13] It began rising again in 2009Q4. 2009Q3 therefore marks the trough of the present cycle while 2009Q4 marks the end of the recession in a technical sense and the start of the recovery (Source: *Quarterly National Accounts, June 2013*). Relative to its peak in 2008Q1 to the trough of the recession, labour productivity (GDP per hour) fell by 4.5% (Table 4). Comparing the latest available period, 2013Q1, with the previous peak, labour productivity was lower still, by 5.1%. And relative to the pre-crisis HP trend, labour productivity in 2013Q1 was 16% lower. So relative to the peak labour productivity fell in the recession and has since stagnated. This is the productivity puzzle.

Labour productivity on a "heads" basis, GDP per job, looks even worse than on an hours basis, at least up till the last three quarters (Table 1). This is because hours fell more than did jobs, an interesting example of the UK's labour market flexibility. Weekly hours per job were declining prior to the recession. But they fell below their extrapolated trend during the recession, though they are now back on that trend (Chart 8).

The UK experience is in sharp contrast to that of the United States. There output per hour in the nonfarm business sector fell initially as the recession began but then recovered strongly. In 2011 growth weakened but was still positive. In 2011Q4 the productivity level was 8% higher than at its previous peak in 2007Q4. On average it grew by 1.9% per year

[13] A year ago the ONS dated the trough of the recession to 2009Q2, but their current view is gloomier.

between 2007 and 2011. By comparison productivity grew at 2.5% on average over 2000-2007 and 2.1% over 1990-2001.[14] So there is no crisis in US labour productivity, despite the fact that during the recession GDP fell by about the same proportion in the US as in the UK. The UK productivity performance post-recession also seems to have been worse than in most EU countries (Hughes and Saleheen (2012)).

3.2 Sectoral analysis

Some insight into the productivity puzzle comes from breaking down the economy into sectors. Table 3 shows a breakdown into 17 sectors; output in these sectors aggregates to GDP.[15] This table shows the share of each sector's value added in aggregate value added (GDP) in the last year of the boom, 2007. Also shown are the 2007 shares of each sector in aggregate hours worked. If we divide the share in GDP by the share in aggregate hours we get the relative labour productivity of each sector (value added per hour in each sector divided by aggregate value added (GDP) per hour); this is shown in the last column. The level of labour productivity varies widely across the 17 sectors, from a low of 0.39 in "Agriculture, forestry & fishing" to a high of 10.65 in "Mining and quarrying including oil and gas". So, hypothetically, holding the productivity growth rate in each sector at its

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[14] Source: US Bureau of Labor Statistics, www.bls.gov.lpc/prodybar.htm, accessed on 1st March 2012.

[15] These data can be found (with considerable difficulty) on the ONS website at http://www.ons.gov.uk/ons/about-ons/what-we-do/publication-scheme/published-ad-hoc-data/economy/index.html. They comprise output (real and nominal value added), hours worked and workforce jobs (including the self-employed) for each of the 17 sectors. I have used the spreadsheet dated June-July 2013. Real value added is single-deflated, i.e. the growth of real value added is proxied by the growth of real gross output (nominal gross output deflated by a price index for gross output). The basic data on output are derived from employer-based surveys done at the reporting unit level while jobs data are at the local unit level. Reporting units and local units are assigned to industries in accordance with what is declared to be their "principal product". Consequently not every local unit is necessarily assigned to the same industry as that of the reporting unit to which it belongs. For the purpose of productivity statistics, for consistency the ONS reclassifies local units so that they are all assigned to the industry of the reporting unit to which they belong. As a result the series for jobs and hours used to estimate labour productivity, "productivity jobs" and "productivity hours" (which are partially published in the ONS's *Productivity Bulletin*) are not the same as the series for workforce jobs and workforce hours which are published separately in the ONS's regular *Labour Force Statistics* bulletin. Note also that total hours worked are derived from the Labour Force Survey (LFS), as is self-employment, and hours worked in each sector are scaled so that they add up to the LFS total.

observed value but reallocating labour towards (say) a sector with a low productivity *level* could lower aggregate productivity by a significant amount, a point to which we return below.

The influence of hard-to-measure or otherwise problematic sectors

Initially I check whether the overall picture is changed by looking at broad sectors such as the market economy, i.e. GDP excluding government services (Public administration and defence, Education, and Health and social services, sectors O, P and Q), which was 74.1% of GDP in 2010. Next I also exclude sectors which are problematic in various ways. In the government sector (public administration and defence, health and education) great efforts have been made to improve output measurement, but nonetheless more remains to be done; in any case, the incentives in this sector differ from those in the rest of the economy. There are some sectors where labour productivity was declining prior to the recession and other sectors whose performance cannot be taken at face value (see below). Some of these problematic sectors are natural-resource-dependent, such as Agriculture (A) and oil and gas (B), in others there may be measurement issues, e.g. Financial and insurance activities (K). It is often suggested that banking output was overstated in the boom (more on this below).[16] I also exclude the imputed rent of owner-occupiers from Real estate (L) since there are no hours worked associated to this form of output. The resulting aggregate (MEX) was 61.6% of GDP in 2010. I calculate real gross value added (GVA) in these broad sectors using the ONS methodology (annually chain-linked Laspeyres indices).

The results of these calculations are in Table 4. Column 1 shows the official figures for labour productivity, GDP (at basic prices) per hour. Column 3 shows the market economy (ME) and columns 4 shows the MEX aggregate. There is very little difference between the performance of these aggregates, though MEX has perhaps done a shade better since the trough (see also Charts 9 and 10).

Reallocation of labour to sectors where productivity is lower

Has the aggregate productivity performance been materially affected by resources shifting from high productivity sectors to low productivity ones? We can see whether this was the

[16] See Burgess (2011) and Oulton(2013) for discussion of the problems in measuring the output of financial services.

case by calculating what GDP per hour would have been if productivity had risen in each sector at the rate actually observed but the allocation of labour across the sectors was the same as in 2007, i.e. the 2007 labour shares continued unchanged at their Table 3 values. The result is in column (4) of Table 4: holding labour shares constant makes virtually no difference (a conclusion already reached by Martin (2011)).

Despite this negative result, a shift away from high productivity to low productivity activities *within* (rather than between) sectors might have further explanatory power. Suppose that in the recession shoppers shift from high margin to low margin stores. The high margin stores offer a better shopping experience or better service but their prices for comparable products are higher (think of buying bananas in Harrods Food Hall compared to in your local Tesco). This shift would show up as a fall in output and productivity in the official statistics. The same effect could arise if there is a shift towards cheaper, own-brand products within a given store. [17]

The productivity puzzle at the sectoral level

Charts 11 to 28 show the course of labour productivity in each of the 17 sectors of Table 3. Included in each chart is a trend line estimated by the Hodrick-Prescott filter over the pre-crisis period 1997Q1-2008Q1 (with parameter set to 1600 since these are quarterly data) and extrapolated beyond then to the end of the period (2013Q1). In all these charts the vertical axis is on a log scale so that growth rates can be read off from the slopes of the lines. A red bar marks the period of the recession proper, i.e. the period when GDP at market prices was falling (2008Q1-2009Q1).

The general conclusion from looking at these charts is that the productivity puzzle is very widespread. When we first looked at these data (Oulton and Sebastiá-Barriel 2013), we thought we could discern a number of patterns:

1. Sectors where productivity was stagnant or declining before the recession began but where performance has deteriorated further since the recession (7.3% of GDP in 2007).
2. Sectors where the productivity *growth rate* had recovered to roughly its pre-crisis value, but where the productivity *level* is still below the previous peak (and a fortiori

[17] Philip Clarke, Tesco chief executive, argues such a shift has indeed taken place since the recession began ("Lessons from the supermarket for austerity Britain", *Financial Times*, 19 October 2012).

below the pre-crisis trend line): 25.7% of 2007 GDP. This category corresponds to the "pessimistic" case of Figure 1.

3. Sectors where productivity growth is still below its pre-crisis rate and where the productivity *level* is still below the previous peak (and a fortiori below the pre-crisis trend line): 24.6% of 2007 GDP. This category corresponds to the "very pessimistic" case of Figure 1.
4. A sector, Information and communication (J), where both productivity growth and the productivity level are close to the pre-crisis trend: 6.0% of 2007 GDP.

The passage of a year has brought additional data but also considerable revisions. Most sectors now fall into the "very pessimistic" category, including Manufacturing (C), Chart 13, Wholesale and retail trade (G), Chart 17, and Finance and insurance activities (K), Chart 21. Previously government services looked to have performed quite well but now they seem just as subject to the productivity puzzle as other sectors (Chart 26). Information and communication (Chart 20) now also appears to be in the "very pessimistic" category. As before there are some maverick sectors. Productivity growth in Construction (F) is very erratic but the trend was declining prior to the recession. The latest data puts this sector right on its falling trend. In the utilities too trend productivity was declining prior to the recession and actual performance has worsened since (Charts 14 and 15). Presumably regulation (e.g. the cost of meeting higher environmental standards) has played a role here. Other sectors on a declining trend before the recession were Agriculture (A), Chart 11, and Oil and gas (B), Chart 12. The latter has done particularly poorly since then. Presumably geology is the main explanation. Finally, Real estate (L) is a particular puzzle (Chart 22). Before the recession productivity was declining but after the recession it rises sharply, and this despite the fact that we have stripped out the imputed rent of owner-occupiers.

3.3 Mis-measurement of GDP due to mis-measurement of banking output

It is frequently argued that the output of the banking industry was overstated during the boom. Bankers were selling financial products of low or no social value ("toxic rubbish") to ignorant or greedy clients. So if banking output were measured correctly it would be seen to have grown more slowly than the official figures from the Office for National Statistics (ONS) suggest. Consequently, since banking is a large industry in the UK, the growth of real GDP must have been overstated too. If this argument is correct, it would have serious consequences, not just for our view of the recent past but also for our view of the likely future. For if British growth in the run-up to the crisis was slower than we originally thought, then our view of the likely future path of GDP should be correspondingly more pessimistic, even when the economy has fully recovered from the Great Recession. Equally, if GDP in the boom was overstated, but is more accurately measured now, then some of the sting from the productivity puzzle will have been removed.

Elsewhere I have argued that this argument is wrong (Oulton 2013). Even if the premise is correct ("Banking output has been overstated"), the conclusion ("GDP growth has been overstated") does not follow. The error in the argument derives from a failure to understand how the ONS actually constructs its estimates of real GDP. Closer to the truth would be the assertion: "if banking output has been overstated, then the output of some other industry or industries must have been understated". Briefly, the reason why the argument is wrong is that the Office for National Statistics measures the real growth of GDP primarily from the expenditure side (GDP(E)). And from the expenditure side most of the problematic part of banking output drops out since this part is intermediate consumption rather than final expenditure. For example, any financial product sold to a domestic business is intermediate consumption and the services generated by selling mortgages to owner occupiers are also intermediate (they show up as a cost of producing the implicit rent of owner-occupiers).

The ONS also measures the growth of real GDP from the output side (GDP(O)). But the output side estimate is "reconciled" with the expenditure side one by adjusting the growth rate of some industries (including banking) till the two estimates are equal (within narrow limits). I calculated that any overstatement of GDP growth due to errors in measuring final expenditure on banking services is not likely to have exceeded 0.1% p.a. over 2000-2007.

3.4 Overheating in the boom?

Suppose that in the boom the economy was operating at a progressively higher level of demand pressure. In other words, productivity was growing faster than its true trend rate. Then the fall in productivity experienced after the boom ended would exaggerate the true decline or even conceivably eliminate it altogether. Table 5 and charts 30-33 gather together four indicators of demand pressure. From the expenditure side there is the growth of the GDP deflator (at basic prices) and the ratio of net exports to GDP (in current prices). From the labour market side there is the unemployment rate and the employment rate of those aged 16-64.

None of these indicators show any sign of trending upwards over the period 2000Q1 to 2008Q1. True, the unemployment rate fell, and the employment rate rose, over 2000-2002 but after that they stabilised. The net export ratio also fell between 2000 and 2002 but it too stabilised. Given that inflation was low and showed no sign of accelerating over this period (it was after all part of the "Great Moderation"), there is no evidence of excessive pressure of demand, still less of growing pressure.

3.5 Lower physical capital input?

One possible explanation for lower labour productivity is a decline in capital services per unit of labour, due to lower investment since the Great Recession began. The ONS has recently published estimates of TFP which go up to 2010 (Appleton and Franklin (2012)). From their figures it is possible to estimate that the contribution of the growth of capital services per hour worked (capital deepening) to whole-economy GDP was 1.02 percentage points in 2008, 1.64 percentage points in 2009, and 0.59 percentage points in 2010, i.e. it was positive in all three years. Estimates for the market sector have been provided by Goodridge *et al*. (2012) whose annual estimates go up to 2009. They show that the contribution of capital deepening to the growth of output per hour in the market sector was small and positive in 2008 and small and negative in 2009 (see their Tables 7 and 8). This was the case whether the contribution of capital is measured on the current national accounts basis or on an extended basis including additional intangible assets such as R&D stocks. So though investment has fallen, the fall was not large enough to cause a significant decline in capital services per worker (partly because hours worked have also fallen). So the fall in investment cannot explain the fall in labour productivity.

Pessoa and Van Reenen (2013) have recently taken a contrary view and claimed that most of the productivity puzzle can be explained by a simple mechanism. The UK labour market is now exceptionally flexible. In the face of a massive demand shock, real wages have fallen by about 4% (Chart 29) while the cost of capital has risen. This has led firms to reduce the quantity of capital per worker. Consequently output per worker, i.e. productivity, has fallen. This is a seductive story but is it true?

Pessoa and Van Reenen estimate the whole economy capital stock from 2008 onwards by updating the "net capital stock" in 2008 with an aggregate real investment series, employing the perpetual inventory method. They employ the standard capital accumulation equation:

$$K_t = (1-d)K_{t-1} + I_t$$

Here K is capital, I is gross investment and d is the depreciation rate. They assume a quarterly depreciation rate of 2.2%. They then calculate the growth of capital per worker which they call capital deepening (or capital shallowing when it is negative). They find that between 2008Q2 and 2012Q2 GDP per worker fell by 3.6% while capital per worker fell by 5.0%. Applying a capital share of 1/3, they conclude that capital shallowing accounts for about two thirds of the productivity puzzle.

Their paper is not very clear about which measure of capital they are using for their starting stock but it appears to be the Blue Book estimate of net capital stock. The problem with this measure of capital is that it is not consistent with the investment series commonly used in the ONS's Perpetual Inventory Model (PIM) of capital. For example, the stock figures include the value of land; also, the valuation basis is different.

As we have already seen and they acknowledge, their estimate is out of line with the official one, where the two can be compared. Unfortunately official figures are not currently available for any year after 2010. I have therefore produced my own estimates by a similar method, the PIM. But I use business investment, which is arguably more appropriate for productivity analysis. So this is capital in the market sector. My measure of capital deepening is the growth of capital per hour worked in the market sector. If available, hours are more appropriate than heads.

Business investment has of course fallen massively since the Great Recession began. But a fall in investment does not necessarily imply a fall in the capital stock, still less a fall in capital per hour (or per worker).

A quarterly ONS series on real investment in the business sector (chained volume measure; ONS code NPEL) is available from 1987 up till the present. A perpetual inventory calculation requires an initial capital stock which in this case is lacking. So to start with I assume an initial stock of zero at the beginning of 1987: this is the first round. This already produces estimates of the stock in later years which are not too bad (given the other assumptions): at an 8% annual depreciation rate any initial stock has decayed to only about 12% of its 1987 level by the end of the period 25 years later. But we can do better. I take the capital-investment ratio at the end of the period as estimated by the first round and assume that it applies at the beginning of the period too. This generates a better estimate of the initial stock. The process can be repeated. After the third round the growth rates of capital do not change much. My estimates from the third round appear in Table 6. Looking first at the left hand panel, my preferred results use an annual depreciation rate of 8% (2.063% quarterly, the first column) but I also show results for 6% and 10% annual rates (columns 2 and 3).

It turns out that the growth rates of capital are not very sensitive to the assumed depreciation rate in the period of the Great Recession and its aftermath (2008Q2 onwards, though the peak for capital per hour was in 2007Q4). The growth rate of capital has been positive in every quarter from 2008Q1 to 2012Q4 though growth has been at around half the rate of the boom period.

Hours initially fell but have been generally rising since 2010Q2. As a result, there have been quarters when capital deepening was negative, particularly from 2011Q3 to 2102Q3. Nonetheless, the broad trend is upward: assuming an 8% annual depreciation rate, capital per hour had in 2010Q3 increased by 9% relative to the pre-recession peak (see Table 6). Since then capital per hour has been declining. But the level in 2012Q4 was still 7% above the pre-recession peak in 2007Q4.

These estimates use what I call the “old series” for business investment. In July the ONS released what I call the “new series” which it claims to be an improvement mainly due to more disaggregated deflation of nominal investment in different assets. The new series differs in many respects from the old and some of these differences seem highly implausible. So it would not be surprising if the new series was eventually revised. Having said this, the right hand panel of Table 6, derived from the new series, shows a very similar picture to the left hand one: there is no evidence of capital shallowing.

I have repeated these calculations using total gross fixed capital formation (ONS code: NPQT), available from 1955Q1, instead of business investment. This series is not really appropriate for productivity analysis since it includes housing. Nonetheless it shows a similar pattern to business investment post-recession.

These calculations show that far from falling, capital per hour has been rising since the recession began. On my preferred depreciation measure (8% p.a.), in 2012Q4 it was 7% above the pre-recession peak of 2007Q4, using the old series, and 4% higher using the new series.

I therefore conclude that the estimate of capital per worker in Pessoa and Van Reenen is incorrect. A likely explanation is that they used an initial stock in 2008 which is too large and not compatible with their investment series. Hence they show declining capital per worker after the recession began. My series, which is very little affected by my (more distant) initial stock, shows to the contrary a generally rising level of capital per worker.

Where does this leave the productivity puzzle? In a word, still pretty puzzling! Why are firms adding to their capital stock in the face of falling real wages and falling productivity? Of course the estimates here (like those of Pessoa and Van Reenen) are pretty crude, certainly well below the standards recommended by the *OECD Capital Manual*. What we need are investment series by asset type and by sector, like the ONS used to publish. Then we could estimate capital services (not stocks) for each sector, to appraise properly the role of capital deepening in accounting for productivity growth.

These calculations employ the concept of investment laid down in the current System of National Accounts under which some types of intangible investment such as software are included but some are excluded. Goodridge *et al*. (2013) argue that intangible investment is part of the explanation of the productivity puzzle, for two reasons. First, intangible investment, particularly expenditure on R&D which is not currently counted as part of investment in the national accounts, has held up well during and after the recession. So if R&D is included in GDP as a form of investment (as it will be when the new System of National Accounts is adopted), GDP will be seen to have fallen by less than on the current official estimate; they estimate that GDP in the market sector would have been 1.6% higher in 2012. Second, they argue that intangible investment, particularly in R&D, generates positive externalities. Intangible investment slowed down in the early 2000s and this could have led to a slowing of TFP growth after the boom. These two effects together could account, they argue, for about a third of the 16% percentage point fall in labour productivity relative to trend in 2012.

3.6 Lower human capital (skill)?

Falling labour productivity might be explained by falling labour quality. Unfortunately for this explanation, labour quality and quality-adjusted labour input have increased by about 7% since 2007Q1: see Chart 34. This is not very surprising since in a downturn less skilled workers are more likely to lose their jobs. So far from helping to explain it, this deepens the productivity puzzle (Franklin and Mistry, 2013).

3.7 Labour/capital hoarding?

That output per hour should fall during a recession is not surprising. This is in fact the normal experience. One common explanation is labour hoarding: firms tend to hang on to labour during a downturn to avoid firing costs and then hiring costs during the subsequent upturn. An alternative explanation is that some labour has an overhead character, for example the security guards looking after a building (as long as the building continues in use and is not sold, abandoned or demolished). What is puzzling in the British case is that five years after the onset of the recession labour productivity is still below its previous peak and well below its previous trend. Certainly output too is below its previous trend but why have firms not adjusted to this by reducing labour input (either hours or jobs)? If potential labour productivity has been growing at something like the pre-crisis rate, it is hard to understand why firms should want to hang on to labour. In fact, jobs in the market sector have been increasing since 2010Q1. And evidence from business surveys (reviewed by Dale (2011)) suggests that there is little spare capacity.

The case for labour hoarding has been forcefully argued by Martin and Rowthorn (2012). Their argument mainly rests on the importance of overhead labour. They also point out that both human and physical capital per worker have increased during the recession (see above), so on these grounds we would expect labour productivity to have risen not fallen. They also argue that the alternative, damage hypothesis is inherently implausible: why should disruption in the banking sector lead to loss of knowledge of how to produce output in the rest of the economy? (I return to this issue below).

The cost of making a worker redundant in the United Kingdom is quite substantial, about £12,000 or slightly less than half the average annual wage according to the CBI (cited in Faccini and Hackworth (2010)). So this could easily explain why firms are reluctant to fire workers at the beginning of a recession, especially if they expect to have to rehire the same or similar workers in about a year’s time. But five years after the recession began this explanation looks increasingly thin. According to Faccini and Hackworth (2010) again, employment protection legislation (EPL) has not changed much since the mid-1980s on the OECD’s measure, though it may now possibly be enforced more rigorously. They also find two other factors which go the other way. First, the flexibility of real wages has increased since 1993 (partly due to the decline in unionisation), which has helped to maintain employment in the downturn. Between 2008Q1 and 2013Q1 real producer wages fell by 4.4%; in the private sector they fell by 6.6% (Table 7 and Chart 29). Second, the costs of hiring may have increased since the average skill level of the workforce is now higher than in previous recessions; this would make firms more reluctant to fire workers in the downturn.

Given the length of the productivity downturn the labour hoarding hypothesis must rely on firms retaining labour because of its overhead character. But (to use the earlier example) a building, say a shop, may require a security guard but at some point it is cheaper to sack the guard and close the shop down rather than keep it in operation in anticipation of an upturn in sales. However this argument is only qualitative and the question clearly needs more research.

Capital rather than labour hoarding i.e. lower capital utilisation, may be a more plausible mechanism, as a simple numerical example can show. Suppose a firm has a chain of 5 shops each employing 10 workers and each selling 10 units per period. So total sales and total employment are each 50. Let the pre-crisis position be as shown in the first rows of the table below:

Hypothetical reaction of a retail chain to a fall in sales

	Shops					
	1	*2*	*3*	*4*	*5*	*Total*
Pre-crisis						
Sales	10	10	10	10	10	50
Employees	10	10	10	10	10	50
Crisis						
Sales	8	8	8	8	8	40
Employees	10	10	10	10	10	50
After firm's reaction						
Sales	10	10	10	10	0	40
Employees	11	11	11	11	0	44

Now the recession begins and total sales fall by 20%, from 50 to 40. So sales at each store are now 8 (the *Crisis* rows). Assume that there is some breakeven level of sales below which a shop makes losses, say 9 units per period. So now the firm is making losses when pre-crisis it was making profits on all its shops. The firm deals with this situation by closing one of its shops, say the 5th. Customers of this shop transfer to the other four shops. (This might seem a bit unrealistic but the firm may gain customers from other shops which are being closed down too). What about employment? The firm might simply sack the 10 workers employed at the 5th store. But if wages fall then the firm might find it profitable to transfer some of them to the other 4 stores. In the example of the table the firm sacks 6 workers who previously worked at shop 5 and retains 4, allocating one extra worker to each of the four surviving stores (or sacks all 10 but hires 4 new workers).

In this example, labour productivity which the ONS would measure essentially by sales per employee has fallen from (50/50 =) 1 to (40/44 =) 0.91 or by 9%. The fall in productivity has been accompanied by a fall in *effective* (utilised) capital per worker which has fallen from (5 shops/50 workers =) 0.1 shops per worker to (4 shops/44 workers =) 0.09 shops per worker. So the firm has substituted extra labour for less capital actually in use. This is acceptable to the firm because wages are lower; the extra labour can be employed to provide a better service to customers (better service is not captured in the ONS productivity measure).

What about the 5th store which is standing empty? At some point the firm will want to sell it if sales do not revive. But selling it right away might be difficult if all retail firms are facing the same difficulties. And transferring it to other uses may be costly and time-consuming in a country like Britain where planning permission would be required. Demolishing the store is unlikely to be a more profitable (or legal) option than just leaving it standing empty.

This story of falling *effective* capital per unit of labour is compatible with rising *actual* capital per unit of labour which increases from (5/50 =) 0.1 to (5/44 =) 0.11 in the example. So a typical PIM calculation would still give the correct answer (since the 5th shop still exists) but does not take into account the fall in utilisation. How much can be explained by this story I do not know. But it does have the virtue of showing how a fall in real wages induced by a fall in demand for labour can lead to a productivity decline, even while capital per worker is rising. The story is potentially applicable outsider retailing, e.g. to manufacturing: the mothballing of plants or production lines could lead to a similar result.

In this form the story is now not really about labour hoarding but capital hoarding: labour is fully utilised but capital is not. Capital is not fully utilised because it takes time to dispose of or to convert to some new use.

3.8 Crippled banks and zombie firms?

There is considerable anecdotal evidence of apparently sound firms being denied credit on reasonable terms after the banking crisis began. Banks were trying to repair their balance sheets and this was at the expense of their business customers (as well as of potential home owners). The opposite accusation is also often made: banks have exercised forbearance, i.e. they have rolled over loans to insolvent businesses, or forgiven interest payments, because they were unwilling to recognise the losses on their balance sheets. Certainly the number of insolvencies has been surprisingly low given the depth of the recession.

The denial of credit to sound firms presumably affects small and medium sized enterprises (SMEs) more than large ones since the latter have access to stock market finance, which is available now at very low interest rates; in any case the corporate sector as a whole is in financial surplus and holds very large cash balances. Denial of credit has to show up somewhere. It may be part of the reason why business investment has fallen. If so, we have already taken it into account in the discussion of capital input above. It might show up in other ways. One possibility is that firms economise on working capital and this could lead to lower productivity; for example a manufacturing firm might hold fewer spare parts and this would lead to more down time and so to lower labour productivity. But inventory-sales ratios do not seem to have fallen since the recession began. Another way that firms could economise on finance is by employing fewer people. But here the evidence goes the other way. It is SMEs who have been less willing to shed labour than larger firms who are presumably less affected by credit constraints.

The zombie firms story bring an element of déjà vu to those of us who remember the controversies surrounding the 1980-81 recession. Then it was often claimed that the apparent productivity improvement in manufacturing was due to a “batting average” effect: the elimination of the lowest productivity firms through bankruptcy (for cricket fans, this is like not allowing the tail-enders to bat which raises the average but not the total score). The zombie firms claim is the batting average argument in reverse: now it is supposedly the least productive firms who survive through forbearance by the banks, so dragging down the average productivity level. But when the economy is still in a slump, loss-making firms are not necessarily the same as low productivity firms. In principle this question could be settled through microdata analysis.[18] At the time of writing, this analysis has yet to be done. For the moment I am sceptical that zombies can account for a large part of the productivity puzzle.

4 The impact of austerity

Has austerity fundamentally changed the outlook for the UK economy? The issue I want to deal with here is not so much whether a laxer fiscal policy would have raised GDP and labour productivity in the period from 2008Q2 up till the present, but whether the long run prospects for the UK have been damaged in some way by austerity. The underlying issue is the impact of a temporary fiscal stimulus on long run growth. But to get at this it is first necessary to consider what the short run impact of such a stimulus is.

4.1 Fiscal stimulus in theory

The palaeo-Keynesian story that I was taught when I first learnt macroeconomics was along the following lines. In the midst of a recession or depression the government should raise its spending on goods and services, financing the additional expenditure by issuing more bonds. This generates additional employment drawn from the ranks of the unemployed. The newly employed workers spend most of their wages and this generates additional demand for goods and services which in turn leads to additional employment, and so on. The process eventually peters out due to various leakages into saving, taxation and imports. The size of the fiscal multiplier depends on these leakages but is expected substantially to exceed one. This is a very natural and intuitive account. But we now know that it is completely wrong. Why? Because it is not micro-founded. Modern macro tells a very different story. Now we have to work quite hard to show that the multiplier is positive let alone of significant size. We have to work particularly hard to show that the consumption multiplier is not negative.[19]

Hall (2009) shows that in the most stripped down version of a modern macro model, the output multiplier cannot exceed 1 and the consumption multiplier (1 minus the output

[18] Microdata analysis eventually settled the issues around the 1980-81 recession. A large part of the productivity improvement was due to productivity growth in surviving firms (Oulton 2000; Disney *et al*. 2003).

[19] This is an illustration of the old joke that in economics the questions don't change, only the answers.

multiplier) is never positive. Furthermore, the real wage must decline for the output multiplier to be positive. (A rightward-shifted labour supply curve meets a downward-sloping labour demand curve). In this model, the output multiplier calibrated on US data would be about 0.4 and the consumption multiplier minus 0.6. Hall then complicates his model by introducing successively (a) an endogenous markup of price over cost (the markup is lower in booms); (b) the Mortensen-Pissarides labour supply function, which raises the output multiplier quite a bit while still leaving the consumption multiplier negative; and finally (c) consumption-work complementarity in household choice. These assumptions collectively get the likely value of the output multiplier up to about 1 and of the consumption multiplier to about zero. These values are for the static case. Introducing dynamic considerations tends to make the multiplier smaller and declining over time, for example from about 1 to about 0.5 after 8 quarters. All these theoretical results are for a temporary increase in government expenditure.

Subsequently DeLong and Summers (2012) suggested that in a recession and with the economy at the zero lower bound (ZLB) for interest rates, when they argue that the multiplier can be expected to be higher than usual, a fiscal stimulus could be self-financing: the stimulus will generate sufficient additional tax revenue and/or reduced transfers to finance the interest payments on the extra debt. Putting it the other way round, austerity could be self-defeating, worsening the budget deficit rather than improving it. Their condition for a "fiscal free lunch" is:

$$r \leq g + \frac{\eta\mu\tau}{1-\mu\tau} \tag{22}$$

Here r is the real interest rate, g is the trend growth rate of GDP, μ is the fiscal multiplier, τ is the marginal tax and transfer rate, and η (the new wrinkle) is the hysteresis parameter, defined as the per cent reduction in the flow of potential future output per percentage-point-year of the current output gap. They argued that this condition was likely to be satisfied in the US. The crucial parameters here are η and μ. If either is zero then the condition becomes $r \leq g$ which is not likely to be satisfied in the UK, except in the short term. Note however that, as Ramey (2012) points out in her comment, their model is not micro-founded and so for most macroeconomists represents a step backwards. However that may be, there are also empirical issues. The hysteresis effects (summarised by η) to which DeLong and Summers point include higher unemployment (leading to loss of skills and motivation, etc) and a lower capital stock. Ramey is rather sceptical about the claim that a fiscal stimulus has a positive effect on private investment since her VAR analysis shows it to be negative. In the UK context the rise in unemployment has been fairly small (otherwise we wouldn't have a productivity puzzle) so this form of hysteresis is much less likely to be important here (though potentially important in France and very important in southern Europe). Ramey's VAR analysis also shows the effect of a fiscal stimulus wearing off after about four years. So this leads me to wonder whether the DeLong-Summers policy might require a *permanent* rather than a temporary fiscal stimulus, or at least a series of "temporary" stimuli.

Empirical evidence about the size of η seems hard to come by. Discussants of the DeLong-Summers paper also argued that it could be zero or negative since the former had only discussed factors likely to lead to a positive number.[20]

4.2 Econometric evidence on the size of the multiplier

The estimates for the multiplier in Hall (2009) discussed above are generated by calibrating the various models. Evidence also comes from econometric analysis. In OLS regressions of GDP on military expenditure (used because it is plausibly exogenous) for the US over 1930-2008, Hall finds an output multiplier of 0.55 with a standard error of 0.08; the consumption multiplier is close to zero. This estimate is heavily influenced by the inclusion of the second world war years: running the same regression over 1948-2008 and still more so over 1960-2008 makes the multiplier insignificantly different from zero. Estimates derived from VARs produce a range of estimates but generally in the range 0.5 to 1.0.

All this is for the US, a large, rich and relatively closed economy. Ilzetzki *et al*. (2013) provide evidence for a range of countries. They find that the impact of government expenditure shocks depends crucially on key country characteristics, such as the level of development, exchange rate regime, openness to trade, and public indebtedness. Based on quarterly data for government expenditure in 44 countries, they find that (i) the output effect of an increase in government consumption is larger in industrial than in developing countries; (ii) the fiscal multiplier is relatively large in economies operating under predetermined

[20] In his blog DeLong cited estimates of the effect of banking crises on GDP per worker derived in my paper with Maria Sebastiá-Barriel (Oulton and Sebastiá-Barriel 2013) as providing evidence on the size of η (http://delong.typepad.com/sdj/2013/01/nicholas-oulton-and-mari%CC%81a-sebastia%CC%81-barriel-report-that-hysteresis-effects-of-financial-crises-are-large.html). I discuss our results in section 5. But I don't think it is straightforward to interpret our results in the way DeLong suggests.

exchange rates but is zero in economies operating under flexible exchange rates;[21] (iii) fiscal multipliers in open economies are smaller than in closed economies; (iv) fiscal multipliers in high-debt countries are negative. The UK is a middle-sized and very open economy, with a flexible exchange rate and with a rapidly rising debt-GDP ratio (see below). So these results certainly suggest that the multiplier in the UK today could be low and possibly even zero.

Possibly more directly relevant for the UK are the estimates of Crafts and Mills (2012) for interwar Britain. They report estimates of the fiscal multiplier based on quarterly data using modern time-series econometrics. They find that the government-expenditure multiplier was in the range 0.3 to 0.9 even during the period that interest rates were at the ZLB; contrary to the theoretical argument of Christiano *et al*. (2011), they find no evidence that it was higher at the ZLB. They argue that the scope for a "Keynesian solution" to the recession was much less than is generally supposed. In the later 1930s but not before Britain's exit from the gold standard, there was a "fiscal free lunch" (in the sense of DeLong and Summers) in that deficit-financed government spending would have improved public finances enough to pay for the interest on the extra debt.[22] However they note that the fiscal free lunch required capital controls and financial repression to hold down interest rates. So perhaps anti-austerians should be dusting down these tools, which were widely employed up till the 1980s, e.g. requiring UK banks and building societies to hold UK gilts in specified ratio to their deposits, imposing controls on outward investment, and limiting the amount of foreign currency UK tourists can take abroad.[23]

Less discussed has been the impact of tax changes. Using a narrative approach to classify UK tax changes into endogenous and exogenous, Cloyne (2013) finds that a 1 per cent cut in taxes as a proportion of GDP increases GDP by 0.6 per cent on impact and by 2.5 per cent over three years. So tax cuts seem to be self-financing, at least in the medium run. Similar results using the narrative approach have been reported for the US by Ramey and Ramey (2010). The mechanism at work here is presumably that tax cuts improve incentives and efficiency.

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[21] This of course is in accordance with the prediction of the "old Keynesian" Mundell-Fleming model.

[22] Note that the ratio of net central government debt to GDP was 159.6% in 1929 and 171.5% in 1931. This fell to 137.7% in 1939. Source: www.ukspending.co.uk; accessed 24/08/2013.

[23] Employing these tools would of course be inconsistent with EU rules but we are trying to think outside the box now.

4.3 Expansionary contractions

Alesina and Ardagna (2010) raised the possibility that a fiscal contraction could actually be expansionary. The idea has been heavily criticised, most recently by Jordà and Taylor (2013). They find that fiscal policy is more powerful in recessions than in booms. However their sample is 17 OECD countries over 1978-2009. If we cast the net a bit wider we can find remarkable examples of successful contractions.

The aftermath of the Second World War saw a truly savage period of austerity in Britain. Between June 1945 and the end of 1946, 7 million public sector workers lost their jobs with further cuts to come up to 1950. These were of course service men and women who were discharged from the armed forces (about 4.3 million) and workers employed in munitions factories. But over the same 18 month period an extra 5 million civilian jobs were created and the unemployment rate was substantially lower than before the war: 1.5% in 1948 compared to 6.0% in 1939. The employed population fell by 2 million compared to the peak wartime level but this was mostly due to women who were conscripted during the war returning to work at home (a similar effect is observed in the United States). In fact, compared to mid-1939 the working population had increased by 3.435 million by the end of 1948 (Wilson, 1952, Table 1 and surrounding discussion[24]). An expansionary contraction if ever there was one! (A similar story could probably be told for the United States). So I am not convinced that expansionary contractions can be dismissed quite so readily.

4.4 Austerity in practice in the UK

So much for theory and empirical evidence on the size of multipliers. But before we can estimate the impact of austerity on GDP, we need to know how large the cuts have been. Prior to examining this, let's first note that whatever may have been the case for fiscal policy, monetary and financial policy have been extremely supportive. First, UK banks were supported by a huge bailout and two of the largest (RBS and Lloyds-HBOS) were effectively nationalised. Second, Bank Rate was cut. It was 5.75% in November 2007. By April 2008 it

[24] Some of the additional jobs were in state-controlled enterprises like the Post Office (which included telecoms in those days) but the vast bulk was in the private sector. The unemployment rate cannot be directly compared to modern figures since the latter are based on answers to questions in the Labour Force Survey while figures for the 1930s and 1940s are for those (mostly men) claiming unemployment benefit.

had been cut in three steps to 5%, a level maintained till October 2008. From then on it was rapidly reduced till it reached 0.5% in March 2009 where it has remained up till now (September 2013). Third, the exchange rate fell abruptly. The sterling exchange rate index (ERI) stood at a peak of 104.6 in 2007Q1. The low point was reached in 2009Q1 at 77.8, a fall of 26%. It has risen a little since then but still stood at 80.5 in 2013Q1, a fall of 23% from the peak. Though not explicitly the result of policy (no currency manipulation here!), the depreciation was certainly allowed by and a result of our monetary framework. Fourth, once Bank Rate reached virtually the ZLB the policy of quantitative easing was wheeled out under which the Bank of England has acquired 29% of the stock of gilts with the possibility of more to come if the MPC were to so decide (see below). Fifth, there have been various programmes to encourage bank lending to business such as the Funding for Lending Scheme.

Public sector employment and expenditure

One way to gauge the extent of austerity is to look at jobs in the public sector. Between March 2008 when the boom ended and December 2012 the number of public sector workers fell by 288,000 or by 4.8%. Taking account of transfers into and out of the public sector (i.e. reclassifications) increases the fall to 6.5% (Table 8). By itself this represents a fall of 1.3% in total employment. But over the same period total employment actually rose by 0.7%, i.e. gains in the private sector more than compensated for losses in the public sector.

However, because of changes in the degree of outsourcing of activities in the public sector, the number of jobs may not be a very good measure of the government's impact on the economy. So it is better to look at government spending on goods and services, both current and capital. Columns 1-3 of Table 9 show real government (central plus local) expenditure on goods and services, capital, current and total, using the official (ONS) concepts.[25] Real government current spending has been higher in every quarter since the recession began than it was at the peak (2008Q1). Real government investment has followed an erratic course since the recession began. It mainly rose in the last two years of the Labour government and has mainly been lower after the coalition came to power in Spring 2010. But its average level has been about the same as in 2008Q1. Investment is much smaller than

[25] Total real government expenditure on goods and services is not published by the ONS. I have calculated it as an annually-chained Laspeyres index of current and capital spending. In accordance with the official methodology for calculating chain-linked GDP, the weights for 2011 to the present are those of 2010.

current spending. So total expenditure has unambiguously risen since the peak: in 2013Q1 total government expenditure was 6% higher than in 2008Q1. In other words, far from austerity we have had a fiscal stimulus.

We can measure the contribution of government expenditure to growth as the government share (in nominal terms) times the growth rate of real expenditure. The government's contribution since the recession has on average been positive, at 0.09 percentage points per quarter.

It might be objected that the official measures of real government spending are misleading since they incorporate many disputable assumptions about how to measure productivity in the public sector. So I have calculated two alternative, "Keynesian" measures of government expenditure. The idea here is to forget about the social value of government expenditure (the education of children, the care of the sick, etc) and just consider it as an engine for pumping effective demand into the economy. In the first Keynesian measure nominal government expenditure is deflated by the GDP deflator (column 4). Done in this way, government expenditure is higher than at the peak up till 2011Q1 before falling back. In 2013Q1 it was 2% lower than at the peak. From 2008Q2 to 2013Q1 its average level was 100.5. For the second Keynesian measure I take a leaf from the master's book and measure volumes in wage units, i.e. by deflating nominal values by a wage index, as recommended by Keynes in the *General Theory* (Keynes 1936 [1961], page 41). Using the Average Weekly Earnings index as the deflator, the results of this alternative calculation appear in column 5. Again we find that there was a fiscal stimulus: real spending is now nearly 4% higher than at the peak of the boom. On this measure the stimulus was highest in 2009Q1. Though declining since then it has remained positive.

In summary, reports of savage cuts seem greatly exaggerated. Fiscal policy has reinforced monetary policy and has been mildly expansionary. Of course, it is always possible to argue that government expenditure should have been even higher given the depth of the recession. But this view cannot be assessed without paying some attention to budget deficits and the debt.

4.5 Budget deficits and the debt

In the boom period from 2000Q1 to 2008Q1, net lending by the government (central and local) averaged minus 1.69% of GDP, i.e. there was a budget deficit. In the period since then net lending by the government has averaged minus 8.01% (Table 10). In other words since the crisis began there has been a huge blow-out in the budget deficit. It is considerably larger than in France, a country where unemployment (10.9% in May 2013) is much higher and which is supposedly pursuing Keynesian, anti-austerity policies. The deficit is now larger than in some countries such as Greece which the financial markets regard as basket cases.

Chart 35 shows net lending by sector in the run-up to the crisis and afterwards. Households were in increasing deficit in the boom. But this swiftly changed as the recession began and households moved into financial surplus. Corporations (financial and non-financial combined) were in surplus during the boom and have continued to be so during the recession and the ensuing slump (though this masks differences between financial and non-financial corporations whose net lending moved in opposite directions after the peak of the boom). The rest of the world (the negative of the current account of the balance of payments) was in rough balance on the eve of the recession but has moved into surplus since, i.e. the current account has become increasingly negative.

Of course the present UK government has not exactly chosen to run a deficit as large as this. Its size is largely a function of the automatic stabilisers kicking in as GDP fell. But clearly with the exception of a rise in VAT the coalition government has done little to counteract the automatic stabilisers and also as we have seen has not yet substantially cut real spending on goods and services. The continuing large deficits have meant that the debt-GDP ratio has risen at a (to me at least) alarming rate.

4.6 Should we worry about the debt?

Public Sector Net Debt, one measure employed by the Office for Budget Responsibility (OBR), was 75.1% of GDP in March 2013. Between 1987 and 2007 it had hovered around 40% of GDP (Office for Budget Responsibility, 2013). The OBR projects that on current "austerity" policies the net debt ratio will peak at 85.6% in 2016-2017. This projection assumes that government keeps to its spending plans and that the Bank of England succeeds in keeping inflation at the 2% target for the CPI.

The market value of the stock of gilts stood at £1,407 billion on 28 March 2013, which represented 89% of GDP in 2012 (Treasury bills added a bit more). Of this total, £396 billion (28.6%) was held by the Bank of England. Overseas interests held 31.2% of the stock or

43.6% if we exclude the Bank of England holding.[26] Index-linked gilts comprised 27.4% of the total. The market-value-weighted average maturity was 13.75 years (excluding undated gilts) while the duration (including undated) was 9.12 years (Debt Management Office, 2013).

The current expectation is that the Bank of England's gilt holdings (the result of QE) will eventually be sold back into the market when economic conditions permit. If that were not so, and these holdings came to be regarded as permanent, then the years since 2007 would have seen money-financed budget deficits instead of bond-financed ones.

So what are the chances that we will actually have to repay this debt? Could we just inflate it away? After all, this was a large part of the solution to the problem of the debt built up in waging and winning the Second World War (a fairly rapid growth rate in the Golden Age of European catch-up also helped a lot). But in the 21st century this looks much less feasible. First, it would involve junking the current framework of monetary policy. Second, levying an effective inflation tax will be difficult given that nearly a third of the debt is held by overseas interests and more than a quarter is index-linked. The inflation tax can only be effectively exercised against domestic institutions (banks and pension funds) and households, and obviously it won't work against index-linked gilts. Foreigners can always take their money elsewhere.

The debt-to-GDP ratio was apparently even higher in the aftermath of the Napoleonic wars. In 1815 it was 226.4% of GDP, rising to 260.6% in 1819. This turned out to be sustainable, with the ratio falling steadily to 30.2% in 1900, but for different reasons.[27] First, the nineteenth century state was very small. There was only minimal welfare provision (the Poor Laws), no public health service and no public education (till 1870).[28] Britain did not face a serious military threat till the rise of imperial Germany in the last quarter of the nineteenth century so defence spending was low. Second, until the franchise was extended to include the male working class (a process which began with the Second Reform Act in 1867 but was not completed till 1918), the interests of voters, who were also the bond holders, and

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[26] Interestingly this is about the same proportion as in the US where it is often said that the national debt is "something we owe to ourselves".

[27] Source for debt ratios: the spreadsheet 20_data.xls, available from Carmen Reinhart's website (http://www.carmenreinhart.com/data/browse-by-country/countries/united-kingdom), accessed 23/08/2013. The ultimate source is www.ukpublicspending.co.uk.

[28] Maddison (2001) documents that the UK raised only about 12% of GDP in tax revenue around 1910, compared with around 46% by 2000. Corresponding figures for the US are 8% and 30%.

the government were perfectly aligned. So stable prices (enforced by the Gold Standard) and paying interest on time were policies that the political nation could easily agree on. However, the size of debt service as a share of government spending may not have been costless. After all, the latter part of the nineteenth century was the period when Britain lost global economic leadership. Economic historians often point to the failure of Britain to invest in public education, in technical training, and in science and engineering as causes of Britain's loss of leadership. It is possible that debt service payments may have crowded out more socially productive forms of public spending, given resistance to higher taxes.

Many people argue that since the yield on government debt is extraordinarily low the UK has "fiscal space" and so can and should undertake further stimulus. It is true that the current yield on gilts is very low; even on 50 year gilts it is only about 3.5% (Debt Management Office, 2013). But it is difficult to take these market "forecasts" seriously. Presumably they are made by traders who expect to exit their positions (or to retire to their estates) long before market sentiment changes. So the idea that the government could exploit these low yields by abandoning "austerity" seems implausible to me. But even if it could, a high debt ratio may still impose costs via crowding out of socially productive public spending or via inefficiencies induced by the higher tax rates that are eventually necessary. Reinhart and Rogoff (2012) report slow growth in high debt countries even when they are still able to borrow at low rates. As just noted, even under "austerity", the debt-GDP ratio is expected to rise substantially as the budget deficit remains high.

Despite the fact that interest rates are currently low, the burden of interest payments is already non-negligible. In the fiscal year 2012/2013, interest payments were £48.0 billion which was larger than defence expenditure (£44.0 billion) and equal to 55% of spending on education (£86.9 billion).[29]

It is generally agreed that the UK, like other developed countries, has a long-term budgetary problem due to rising health care costs, made worse by population ageing, rising pension costs for the same reason, and increasing welfare payments associated with the high (and until recently rising) proportion of the working-age population classified as disabled.[30]

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[29] Source: http://www.ukpublicspending.co.uk/uk_budget_detail_13bt12012n#ukgs303; accessed 23/08/2013.

[30] In February 2013 there were 12.830 million people in receipt of the state pension, about 20% of the total population. In August 2013 2.93 million people of working age, 7.3% of the population aged 16-64, received some form of disability benefit. This compares to the 1.514 million who received unemployment benefit (Job Seekers Allowance). Including lone parents, carers and others raises the number of working-age people receiving some form of

Opponents of austerity usually acknowledge the long-term problem but argue that this should be put on the back burner while we deal with the aftermath of the recession by a fiscal stimulus. This seems to ignore political economy. In a modern western democracy it is very difficult to cut government spending. It is also even more difficult to raise taxation, as a cursory examination of British history from the Peasant's Revolt of 1381, the Ship Money crisis which preceded and fuelled the descent into civil war in 1642, to the modern day poll tax riots and fuel tax protests will easily show. As I have argued above, the rhetoric of austerity has up to now far exceeded the reality. Even so, the policy has been intensely controversial. So how could a government plausibly commit itself to fiscal stimulus today and fiscal rectitude tomorrow?

4.7 Conclusions on austerity

My conclusions on fiscal policy and the role of austerity in the recession are as follows:

1. The profession has yet to reach a consensus on the size of the fiscal multiplier in a country like Britain. It is possible that the multiplier is quite small, potentially even zero.
2. However that may be, it seems likely that during the current recession and slump, fiscal policy has been expansionary since government spending on goods and services has risen not fallen.
3. Consequently, it is unlikely that "austerity" can explain much if any of the productivity puzzle.
4. Any proposal for a more expansionary fiscal policy than the present one should explain what the effect will be on the debt-GDP ratio and what the economic consequences will be of any significant increase in that ratio, which is anyway expected to rise substantially on current policies.

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state support to 5.695 million, 14.2% of the working age population. Source: *DWP Quarterly Statistical Summary, 14th August 2013*; available at https://www.gov.uk/government/publications/dwp-statistical-summaries-2013.

5 The long run effects of banking crises: evidence from cross-country panel data

All the candidate explanations for the productivity puzzle discussed in the previous two sections arguably all relate to the short-term effects of the financial crisis and the slump which followed it. Even the "crippled banks and zombie firms" hypothesis which relies directly on a malfunctioning banking system suggests only short term effects: when the banking system is restored to health these effects will disappear. So I turn now to possible long term effects. I start by reviewing evidence and theory on the long term effects of financial (particularly banking) crises. Then I summarise the findings of a recent cross-country panel analysis covering 61 countries over 1950-2010 (Oulton and Sebastiá-Barriel 2013).

5.1 Previous empirical findings on financial crises

Reinhart and Rogoff (2010) find that based on data for 44 countries spanning about 200 years, GDP growth rates fall as the gross central government debt-GDP ratio rises (they assign the debt/GDP ratios to four buckets: below 30%, 30-60%, 60-90% and above 90%). The growth effects are similar in advanced and emerging economies.[31] Reinhart and Rogoff (2012) argue that the negative association between debt-GDP ratios and growth cannot be entirely due to cyclical effects (recessions causing high debt) since low growth is highly persistent in highly-indebted countries (so high debt is causing low growth). The very pessimistic case of Figure 1 finds some support in Broadberry and Crafts (1992) who argue that the Great Depression cast a long shadow over the British economy since it led to productivity-reducing policies such as protection and cartelisation of industries.

A number of other studies, e.g. Cerra and Saxena (2008), Furceri and Mouragane (2009), Barrell et al. (2010), Papell and Prodan (2011) and IMF (2009, chapter 4), also find that the recovery from financial crises is very slow. For example, Papell and Prodan (2011) argue that "The preponderance of evidence for episodes comparable with the current US slump is that, while potential GDP is eventually restored, the slumps last an average of nine years." Like Barrell et al. (2010), they argue that advanced countries are different from developing ones: the latter can and do suffer permanent damage from severe financial crises. The claim that

[31] My interpretation takes into account the critique of the published results by Herndon *et al*. (2013) and the subsequent response by Reinhart and Rogoff (2013).

advanced countries are relatively immune to the effects of financial crises is based on the evidence for the period since the Second World War. However, based on a study of nearly 200 recession episodes in 14 advanced countries between 1870 and 2008, Jordà et al. (2012) find that more credit-intensive booms tend to be followed by deeper recessions and slower recoveries.

5.2 Long run effects of financial crises: theory

Why might we expect long-run effects from financial crises? A number of factors might reduce the long-run level of potential GDP, and of potential GDP per hour, even when recovery from the recession is complete (in the sense that GDP is growing at its long-run rate and unemployment is at a level consistent with a constant rate of inflation):

1. Reinhart and Rogoff (2011) argue that financial crises have a tendency to raise the stock of government debt relative to GDP, either because of the cost of recapitalising failed banks or because government expenditure is not cut in proportion to reduced tax revenues. High levels of debt require high levels of taxation to service the debt and this may lead to efficiency losses; also high debt interest payments may crowd out socially productive public expenditure (Barro 1979).

2. In the recent boom, real interest rates were very low, reflecting a mis-pricing of risk. When the recovery is complete and official rates return to normal levels, the rates at which firms can borrow are likely to be higher due to an additional risk premium. So they will want to hold a lower level of capital in relation to output. Suppose that the real interest rate (the required return on capital) rises from (say) 7% to 9%. The depreciation rate averaged over all types of capital can be taken to be 8%. Then the cost of capital rises from (7 + 8 =) 15% to (9 + 8 =) 17%, i.e. by 13.3%. The elasticity of capital with respect to its cost is minus 0.4 according to Barnes et al. (2008). And the elasticity of output with respect to capital is about 1/3 (the profit share). So the effect of the rise in the real interest rate on the long-run level of GDP is (13.3 x -0.4 x 0.3) = -1.8%. This calculation is only illustrative, but does suggest that the effect is not negligible.

3. Higher unemployment during the recession reduces the human capital of the unemployed, by preventing them from gaining the experience that would raise their productivity. Of course, this effect eventually disappears when the affected workers leave the labour force (through emigration, retirement or death) and are replaced by workers who enter the labour market after the Great Recession is over. But even if not permanent, this effect could clearly be long-lasting since youth unemployment has risen particularly sharply in many countries. Suppose that an additional 3.5% of the labour force becomes unemployed as a result of the Great Recession, that this higher rate of unemployment lasts for a period of 5 years, and that each additional unemployed person is unemployed for one year. This is equivalent to (5 x 3.5 =) 16.5% of the labour force losing one year's experience. If the rate of return to experience is (say) 7% per year (which is consistent with estimates of the return to schooling), then the effect on GDP is a reduction of (16.5 x 0.07 x 2/3 =) 0.8%.

4. There could be a long-run effect on the level of TFP. According to this argument the amount of innovation taking place in the economy is temporarily reduced by the recession. Innovation is implemented through or accompanied by investment in intangibles (e.g. R&D, in-firm training, or expenditure of management time on corporate restructuring) or it could take the form of new entrants into an industry bringing new products, new technology or new business methods. All this is (arguably) what lies behind TFP growth as conventionally measured (Corrado et al. (2009); Marrano et al. (2009)). Now since innovation is a cumulative process and since the supply of workers and entrepreneurs capable of innovating is inelastic, a reduction in innovation in one period cannot easily be made up in a subsequent one: in other words, less innovation today means that the future *level* of TFP is permanently lower. For illustration, suppose that prior to a crisis, assumed to last one year, the economy is capable of generating a stream of innovations *a*, *b*, *c*, ... from the current year *t* onwards. As a result of the crisis the first innovation *a* is now delayed to year *t*+1; the subsequent innovations *b*, *c*, ... are now also delayed one year to years *t*+2, *t*+3, ... Though all innovations are eventually introduced the level of TFP will clearly be lower in every year after the crisis is over than it would have been in the absence of the crisis. A reduction in the TFP level will also lead to a secondary effect, a reduction in the desired level of capital, again reducing labour productivity.

These are of course just back-of-the-envelope calculations. What we need is a theoretical framework which would allow us to assess the size of any such effects empirically.

5.3 A theoretical framework

It is important to adopt a theoretical specification which allows for the possibility that financial crises have both short-run and long-run effects and that these effects may be on both the level and the growth rate of productivity. It will then be an empirical issue how large or small these effects are. A fairly general framework for productivity growth can be written as follows:

$$q_{it} - q_{it-1} = \lambda(q_{it}^{*} - q_{it-1}) + \beta(q_{it-1} - q_{it-2}) + (1-\lambda-\beta)(q_{it-2} - q_{it-3}) + \gamma crisis_{it} + \varepsilon_{it}, \quad 0 < \lambda < 1,\ 0 < \beta < 1,\ \lambda+\beta \leq 1,\ \gamma < 0 \qquad (23)$$

Here q_{it} is the log of the level of (labour) productivity in the *i*-th country, q_{it}^{*} is the log of the long-run productivity level in that country (long-run is indicated by a star (*)), $crisis_{it}$ is a one-zero dummy indicating the presence or absence of a financial crisis, and ε_{it} is a mean-zero error term. The first term on the right-hand side, $\lambda(q_{it}^{*} - q_{it-1})$, is a simple partial adjustment mechanism whereby a fraction λ of the gap between actual and long-run productivity is removed each period, presumably through investment in the broad sense. The second and third terms, $\beta(q_{it-1} - q_{it-2})$ and $(1-\lambda-\beta)(q_{it-2} - q_{it-3})$, reflect persistence in productivity growth: aggregate demand takes a while to recover from a recession so factor utilisation is lowered which reduces productivity growth till recovery begins; also investment is depressed for a while. The third term, $\gamma crisis_{it}$, is the short-run effect of a financial crisis on productivity growth. It may reflect a temporary disruption to credit which further reduces investment. We expect that $\gamma < 0$. Note that for the equation to make sense in the long run, the sum of the coefficients on the first three terms on the right-hand side must equal 1 and the specification imposes this restriction.

A second lag in productivity growth is included in (23) since preliminary empirical investigation suggests that this is justified (but not a third lag).

A simple model of the long-run productivity level is:

$$q_{it}^{*} = \alpha_{i0} + \sum_{u=0}^{t-T} \alpha_{t-u} + \sum_{u=0}^{t-T} \zeta_{t-u} + \theta \sum_{u=0}^{t-T} crisis_{i,t-u}, \quad \theta \leq 0 \qquad (24)$$

Here α_{i0} is a country-specific level effect, the α_{t-u} are time period effects, assumed common across countries, and the ζ_{t-u} are country-specific, time-varying shocks; all these shocks are to the productivity level. T is the base period from which all measurements are made. The effect of financial crises on productivity levels is measured by the parameter θ. In this specification financial crises can have a permanent effect on levels unless $\theta = 0$. A permanent effect could arise for example if a financial crisis raises the interest rate permanently leading to permanently lower capital intensity.

For any country the mean of the ζ_{t-u} will be non-zero (probably positive). So split this variable into its mean α_i plus a zero-mean error ξ_{it}: $\zeta_{it} = \alpha_i + \xi_{it}$. Then by subtracting equation (24) lagged once from itself, the long-run growth rate is found to be:

$$q_{it}^* - q_{it-1}^* = \alpha_i + a_t + \theta crisis_{it} + \xi_{it} \tag{25}$$

The long-run growth rate is influenced by a financial crisis only while the latter is on-going. Once a crisis is over, it ceases to influence the long-run growth rate (since then $crisis_{it} = 0$). A more complex model would allow the long run growth rate to be *permanently* by a crisis. But this seems to be asking too much of the data.

In summary, in the specification suggested here, a financial crisis may have a temporary effect on the productivity growth rate (measured by γ in equation (23)) and hence a temporary effect on the productivity level. A financial crisis may also have a permanent effect on the productivity level (measured by θ in equation (25)). But there is no permanent effect on the productivity growth rate. The latter is assumed to be dependent on other factors such as the world-wide development of science and technology and the country's own institutions, all of which are assumed independent of financial crises.

To obtain an estimating equation, lag equation (23) once and subtract the result from (23):

$$\begin{aligned}\Delta q_{it} &= \lambda \Delta q_{it}^* + (1+\beta-\lambda) q_{it-1} - 3\beta q_{it-2} + [3\beta + 2\lambda - 2] q_{it-3} + [1-\lambda-\beta] q_{it-4} \\ &\quad + \gamma \Delta crisis_{it} + \Delta \varepsilon_{it}\end{aligned} \tag{26}$$

Converting the right-hand side to growth rate terms:

$$\begin{aligned}\Delta q_{it} &= \lambda \Delta q_{it}^* + [1+\beta-\lambda] \Delta q_{it-1} + [1-\lambda-2\beta] \Delta q_{it-2} - [1-\lambda-\beta] \Delta q_{it-3} \\ &\quad + \gamma \Delta crisis_{it} + \Delta \varepsilon_{it}\end{aligned} \tag{27}$$

(The coefficients on lagged, actual productivity growth on the right-hand side of (27) sum to $1-\lambda$. So equation (27) has a sensible long-run solution). Using (25):

$$\begin{aligned}\Delta q_{it} = \lambda a_i + \lambda a_t + (\lambda\theta+\gamma)crisis_{it} - \gamma crisis_{it-1} \\ +[1+\beta-\lambda]\Delta q_{it-1} + [1-\lambda-2\beta]\Delta q_{it-2} - [1-\lambda-\beta]\Delta q_{it-3} \\ + \Delta\varepsilon_{it} + \lambda\xi_{it}\end{aligned} \tag{28}$$

In econometric form this can be written as

$$\Delta q_{it} = \phi_{i0} + \sum_{u=0}^{T-1}\phi_{1u}D_{t-u} + \phi_2 crisis_{it} + \phi_3 crisis_{it-1} + \phi_4\Delta q_{it-1} + \phi_5\Delta q_{it-2} + \phi_6\Delta q_{it-3} + \eta_{it} \tag{29}$$

Here the coefficients have the following interpretation in terms of the theoretical model:

$$\begin{array}{ll} \text{Dummies:} & \phi_{i0} + \sum_{u=0}^{T-1}\phi_{1u}D_{t-u} = \lambda a_i + \lambda a_t \\ crisis_{it}: & \phi_2 = \lambda\theta + \gamma < 0 \\ crisis_{it-1}: & \phi_3 = -\gamma > 0 \\ \Delta q_{it-1}: & \phi_4 = 1+\beta-\lambda > 0 \\ \Delta q_{it-2}: & \phi_5 = 1-\lambda-2\beta \\ \Delta q_{it-3}: & \phi_6 = -(1-\lambda-\beta) < 0 \\ \text{Error term:} & \eta_{it} = \Delta\varepsilon_{it} + \lambda\xi_{it} \end{array} \tag{30}$$

The sign of ϕ_5 is ambiguous. The relationship between the underlying parameters and the coefficients (the ϕs) is:

$$\begin{aligned} \beta &= (\phi_4 - \phi_5)/3 = (\phi_4 + \phi_6)/2 \\ \lambda &= 1 + \beta - \phi_4 \\ \gamma &= -\phi_3 \\ \theta &= (\phi_2 - \gamma)/\lambda \end{aligned} \tag{31}$$

The first line of (31) shows that the specification imposes a restriction on the coefficients on lagged productivity growth:

$$\phi_4 + 2\phi_5 + 3\phi_6 = 0 \tag{32}$$

If this restriction is not imposed then there will be two possible estimates of the underlying parameter θ. From (31), these two estimates are

$$\begin{aligned} \theta_1 &= \frac{3(\phi_2+\phi_3)}{3-2\phi_4-\phi_5} \\ \theta_2 &= \frac{2(\phi_2+\phi_3)}{2-\phi_4+\phi_6} \end{aligned} \tag{33}$$

The main interest in what follows attaches to the size of the long-run effect of financial crises, i.e. the absolute sizes of θ.

5.4 Productivity and financial crises: data

We use the data on financial crises gathered and analysed by Reinhart and Rogoff (2009). The actual data are taken from spreadsheets accompanying their book which are publicly available at http://terpconnect.umd.edu/~creinhar. The productivity data derive from The Conference Board's Total Economy Database (TED) for 2011 which is also publicly available online at http://www.conference-board.org/data/ economydatabase.[32]

The Reinhart-Rogoff database of financial crises

Reinhart and Rogoff (2009), hereafter R-R, have gathered data for six types of crisis which they define as follows: see their chapter 1.

1. Currency crisis: defined as an annual rate of decline of the exchange rate of 15% or more.
2. Inflation crisis: defined as an annual rate of inflation of 20% or more.
3. Stock market crisis: defined as a cumulative decline of 25% or more in real equity prices (R-R, chapter 16, page 150).
4. External debt crisis: defined as "the failure of the government to meet a principal or interest payment on the due date (or within the specified grace period)." N.B.: "external" debt means debt incurred under the laws of some foreign jurisdiction. It is usually but not necessarily denominated in foreign currency and typically held mostly by foreign creditors.
5. Domestic debt crisis: defined similarly to external debt crisis. N.B.: "domestic" debt means debt incurred under the country's own laws. It is usually but not necessarily denominated in domestic currency.
6. Banking crisis: defined as "(1) bank runs that lead to the closure, merging or takeover by the public sector of one or more financial institutions and (2) if there are no runs, the closure, merging, takeover or large-scale government assistance of an important financial institution (or group of institutions) that marks the start of a string of similar outcomes for other financial institutions."

Each crisis is measured by a dummy variable, equal to one when a country is judged to be in this type of crisis and 0 otherwise. As they note, the criteria just listed define the onset of a

[32] For further details on data, sources and methods, see Oulton and Sebastiá-Barriel (2013).

crisis. When a crisis ends is largely a matter of judgement. Their data cover 63 countries over the period 1800-2010. We use just the data from 1950 onwards, i.e. the potential number of observations is 61 x 63 =3843.

Here I report results just for banking crises. This is because some of the other R-R crises might be considered *consequences* of banking crises, e.g. a stock market crash. Or they might be thought of as *responses* (whether market-induced or policy-induced). For example, the sharp fall in sterling which accompanied the Great Recession and the UK banking crisis was a market response (though unlike many currency crises in developing or emerging countries it was against the background of an inflation-targeting rather than an exchange-rate-targeting monetary regime). So for the United Kingdom the fall in sterling was not a crisis but part of the adjustment process. Banking crises on the other hand are very hard to predict: models designed to do so have a poor fit even in sample (Corder and Weale (2011)).

For each of the six types of crisis the percentage of total years for which countries were in crisis has increased between the first and second halves of the whole 61-year span 1950-2010. The increase in frequency is particularly sharp for banking crises: over 1950-1979 only 0.9% of country-years was spent in a banking crisis but this rose to 19.8% over 1980-2010. The major events were the Latin American debt crises of the 1980s, the Asian financial crisis of 1997-1998 and the current global financial crisis.

Most crises are short-lived with most lasting less than three years and very few lasting more than six years. Stock market and currency crises have been the most frequent types and these two types have also generated the most crisis years. External debt crises are the most persistent when measured by mean duration; next come inflation crises. Currency crises have the lowest duration. Domestic debt crises are less frequent than other types. Banking crises do not stand out as being particularly frequent or persistent: stock market and currency crises are more frequent and external debt and inflation crises are more persistent, when measured by mean duration.

Output and productivity

The 2011 version of The Conference Board's Total Economy Database (TED) contains national accounts data for 128 countries covering the period 1950-2010, though with missing values for some countries. Labour productivity is available for most countries over the whole 61 year period in heads form but for a much smaller number of countries in hours form.

Hours are better than heads but we do not want to confine the analysis to the richer countries with better statistics. So we used GDP per person engaged (GDP per worker). We construct a measure of capital per worker by applying a PIM to a total investment series from the national accounts data underlying the Penn World Table; we assumed an 8% depreciation rate. Then we constructed the growth of TFP as the growth of GDP per worker minus the share-weighted growth of capital per worker; capital's share was taken to be 1/3. Finally, population is available also from the TED and we used this to construct GDP per capita.

After merging the R-R data in with the TED, we lose about half the countries included in the latter. There are now 61 countries for which we have both labour productivity and crises data for at least some of the 61 years (in fact an average of about 53 years per country, with the missing years being mostly in the 1950s and 1960s). The 61 countries cover the whole planet, not just the OECD; 23 countries are classified as developed and 38 as developing.[33]

5.5 The effect of crises: regression results

Sub-section 5.3 set out a framework within which the average short and long-run effects of crises across our sample can be estimated. We now seek to test this model using the dataset just described. We ran the regression specified in equation (29) with successively the growth of GDP per worker, the growth of capital per worker, the growth of TFP, and the growth of GDP per capita as the dependent variable. The right hand side variables were the banking crisis dummy, the banking crisis dummy lagged, two lags of the dependent variable, country fixed effects, and year dummies. Full details of the results are in Oulton and Sebastiá-Barriel (2013). Here we report results just for the parameter of most interest, θ, which measures the effect of a banking crisis on the long run level of the dependent variable. These results come from estimating (29) by the Arellano-Bond (difference) method; OLS estimates are similar.

The first column of Table 11 reports the results for the full sample (all countries and all years). Let us consider first the effect on GDP per worker. The solution for θ says that a banking crisis has a long-run, permanent impact on the *level* of productivity: it reduces it by about 1.1% for each year that the crisis lasts. In other words a crisis lasting five years would reduce the level of GDP per worker by (5 x 1.1% =) 5.5%, permanently. Of course, the

[33] The data used to generate the results reported below can be found in Stata and Excel format at http://www.bankofengland.co.uk/publications/Pages/workingpapers/2013/wp470.aspx.

estimated effects are for an "average" crisis as experienced by these 61 countries over the period 1955-2010. The estimate of θ is significant at the 1% level.

The remaining columns of Table 11 report various sensitivity tests:

Column (2): exclude the Great Recession (2008-2010).

Column (3): exclude countries affected by the Asian financial crisis of 1997-98. (Korea, Malaysia , Sri Lanka, Taiwan, Thailand, Indonesia, India, Philippines, and China).

Column (4): exclude countries affected by the Latin American debt crisis of the 1980s (Argentina, Bolivia, Brazil, Chile, Columbia, Costa Rica, Ecuador, Mexico, Peru, Uruguay and Venezuela).

Column (5): developed countries only (23 countries).

Column (6): developing countries only (34 countries).

Column (7): early years only (all countries, 1950-1979).

Column (8): later years only (all countries, 1980-2010).

Still sticking with GDP per worker (the top panel of Table 11), the size of θ varies in an interesting way across these sub-samples, though with two exceptions it is always large numerically and negative. Excluding the Great Recession reduces θ numerically from minus 1.096 to minus 1.005, or by 4%, surprisingly little; this may be partly due to the fact that our observation period ends in 2010. Excluding the Latin America countries roughly halves the size of θ numerically; θ now also fails to be significant.[34] This may be another way of saying that these countries managed their crises of the 1980s comparatively poorly. If the regression is run on developed countries only then θ is positive and insignificant (column 5). An optimistic interpretation is that developed countries possess institutions able to deploy policies capable of neutralising the effect of banking crises. A more pessimistic interpretation is that these countries have up till now suffered only mild and isolated crises, e.g. the United Kingdom's secondary banking crisis of the 1970s. Or if the crisis was quite severe, as Sweden's was in 1991-1994, it was against a benign international background. So for the developed countries past experience will not necessarily be a reliable guide to the effects of the present crisis, especially when we consider that the developed countries in our sample include Greece, Ireland, Portugal and Spain. That suggests we should place more weight on the full sample results. Finally, θ is positive and insignificant when the regression is run just

[34] This is a Latin American effect since excluding each Latin American country in turn one by one has little effect on the size and significance of θ.

over the first half of the observation period, 1950-79 (column 7). As we have already seen, banking crises were much less frequent then.

What is the channel through which banking crises damage productivity? Part of the answer to this question comes from looking at the effect of crises on capital per worker. The results appear in the second panel of Table 11 and can be seen to be very similar to the results for GDP per worker, both overall for the whole sample and for the various sub-samples. But now θ is significant (at the 10% level) even when Latin America is excluded; however, θ is not significant when only developed countries are included. So a reduction in the long-run level of the capital stock per worker seems to be a consequence of a banking crisis and helps to explain the earlier finding of a long-run reduction in labour productivity. But this does not necessarily rule out a channel running from TFP, since a long-run reduction in TFP would induce a long-run reduction in capital per worker. And these estimates of the fall in capital per worker are too small by themselves to account for the fall in GDP per worker: if we weight the capital effect by capital's share (say one third), then the capital channel can explain only about a third of the hit to GDP per worker. Looking down to the next panel of Table 10, we see that a banking crisis does indeed reduce the level of TFP. In the full sample, it reduces it by 0.81% for each year of crisis. Again, the effect is not significant for developed countries.

Effects on GDP per capita via labour force participation

A possible criticism of our results is that the effects on labour productivity that we find may reflect differences across countries in labour market institutions.[35] In some countries the response of employment to a shock to output may be smaller than in others. Adjustment may be smaller *either* because of labour market rigidities which make it hard to fire people *or* because of real wage flexibility which reduces the incentive to do so. One way to look at this is to consider the effect of a financial crisis on GDP per capita rather than on GDP per worker. The relationship between the two is: GDP per capita = GDP per worker times the employment ratio (workers as a proportion of the population). So in countries where employment is rapidly cut when output falls there will be a fall in the employment ratio.

There is another reason why the employment ratio may fall. If a banking crisis reduces TFP and there is also an induced fall in capital per worker, then the demand for labour shifts

[35] We owe this point to Chris Pissarides.

to the left. Unless labour supply is completely inelastic there will be a fall in employment relative to population.

We can test for this by running our regression equation (29) with the dependent variable redefined as GDP per capita instead of GDP per worker. We find that the long-run effect of a banking crisis on GDP per capita is substantially larger than the effect on GDP per worker and more significant: see the lowest panel of Table 11. One year of a banking crisis reduces the long-run level of GDP per capita by 1.79%. The effect is highly significant, at the 1% level, even when Latin America is excluded. When only developed countries are included in the regression, the long-run effect is lower though still large, a reduction of -0.79%, and this is significant at the 5% level. In other words, part of the effect of a banking crisis comes in the form of a long-run fall in the employment ratio (whether due to higher unemployment or inactivity rates).[36]

5.6 Conclusions on crises

The results suggest that banking crises as defined by Reinhart and Rogoff have on average a substantial and statistically significant effect on the long-run level of labour productivity. The long-run level of labour productivity is reduced by about 1.1% for each year that the crisis lasts.[37]

One channel through which banking crises do their damage is through their effect on the long-run level of capital per worker. We find that this level is on average reduced by between 0.9 and 1.1% for each year of crisis. We also find that banking crises have a long-run effect on the employment ratio: the level of GDP *per capita* is reduced by 1.7-1.8%. This is substantially larger than the effect on GDP per *worker* (1.1%).

Three qualifications should be noted. First, these results are for all countries combined — advanced, emerging and developing. The Latin American countries have a considerable influence on the size and significance of the effects. If Latin America is excluded, the long run effect of banking crises on productivity is no longer significant. But we still find a highly significant effect of banking crises on capital per worker and also on GDP per capita, i.e. a

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[36] IMF (2009) also finds long-lasting effects on the employment ratio following a financial crisis.

[37] No such significant long-run effects were found for the five other types of financial crisis distinguished by Reinhart and Rogoff, if these latter were not accompanied by a banking crisis (Oulton and Sebastiá-Barriel 2013).

significant effect on the employment ratio. If only the 23 advanced countries are included then banking crises in the period studied (1950-2010) do not have a significant effect on the long-run productivity level. However, crises continue to have a significant (at the 5% level) though smaller effect on the level of GDP per capita, reducing it by 0.7-0.8% for each year of crisis. Second, the banking crisis variable is a zero/one dummy and we have no measure of the severity of any crisis, other than the circular one of looking at its consequences. Because of this second qualification, it would be unwise to take too much comfort from the first one. It may be that the insignificant results found for the advanced countries just reflect the fact that advanced countries have since the 1950s and up to now (and our data stop in 2010) not experienced crises severe enough to generate a statistically significant effect on productivity levels.[38] And third, these are only average effects. No banking crisis is alike. In any particular country or particular period, the impacts may differ substantially from the mean.

6 Two case studies: the United States and Japan

I now consider two case studies, the US after the Great Depression of the 1930s and Japan after the bubble burst in 1990. As we shall see, the US case provides evidence that growth can eventually resume at its previous trend rate, albeit after a massive hit to the level of GDP. This is consistent with the maintained hypothesis of the previous section. The Japanese case to the contrary seems to support the view that the long run growth rate can be permanently affected by a financial crisis.

6.1 The US after the Great Depression of the 1930s

The Great Depression started in the US in 1929, the peak-to-trough decline in GDP was about 27%, and real output did not surpass its 1929 level till 1937 (Crafts and Fearon 2010). Perron (1989) studied the question of whether US GDP has a unit root, i.e. whether it is trend stationary or difference stationary. He found that it was trend stationary: after a one-off shock like the Great Depression is properly taken into account, the US growth rate reverts to its long run trend. But this means that the Great Depression (which was also accompanied by a

[38] Compare again the findings of Jordà *et al*. (2012) for the advanced countries which relate to a longer time span, 1870-2008.

banking crisis) reduced the long-run *level* of US GNP but left the long-run *growth rate* unchanged. In fact, though this was not the focus of his study, it is possible to deduce from his results that the hit to the GDP level was about 17%: see his Table VII and his parameter θ in particular. Ben-David *et al*. (2003) report similar results.

This result leads to a paradoxical conclusion. Suppose that in 1937 you had been asked to project the long run future growth of the US economy. Naturally you would look at past GDP. But as it turned out you would have made a much better forecast if you had only looked at data up to 1929 and ignored everything that had happened afterwards. This would have been a brave thing to do in 1937 and no doubt you would have been regarded as a very foolish person by sensible people.

Why didn't the Great Depression cast an even longer shadow? One reason may be that the policy changes which it induced were not too bad for long run growth. True, the US slid into protectionism (the Smoot-Hawley tariff introduced under the Hoover administration) but in a large economy this had a less deleterious effect than it did in smaller European countries. Some of the Roosevelt administration's more damaging policies, such as price-fixing and cartelisation of industry, were rolled back by the courts. The administration also passed legislation making it easier for unions to organise and get recognised. But US industry never conceded control over working practices on the shop floor to the unions to the extent that UK industry did and some union gains in this area were rolled back after 1945 (Ulman 1968, page 333, citing earlier work by Slichter, Healy and Livernash). By contrast in the UK protection and cartelisation in the 1930s were followed by nationalisation of key industries in the 1940s; together with increased union power, all this arguably hampered UK growth (Broadberry and Crafts 1992). Finally it is interesting to note that the US debt-GDP ratio was quite low on the eve of the Great Depression. While it more than doubled during the 1930s, this was from a low base. The total gross central government debt-GDP ratio was 16.3% in 1929 and still only 43.9% in 1939.[39] Part of the reason why the debt did not rise by more was that (as is well-known) Keynesian fiscal policies were not actually employed by Roosevelt.[40]

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[39] Source for debt ratios: a spreadsheet named 20_data.xls, available from Carmen Reinhart's website (http://www.carmenreinhart.com/data/browse-by-country/countries/united-states), accessed 23/08/2013.

[40] See Crafts and Fearon (2010) for an overview of the US experience, also the more detailed articles in this special issue of the *Oxford of Economic Policy*, especially Hannah and Temin (2010).

6.2 Japan after the bubble burst in 1990

It is often said that Japan has suffered twenty years of stagnation since the bubble burst in 1990. And Japan is often pointed to as an example of the dire consequences of a financial and banking crisis. So my contention that in the long run the UK growth rate will be unaffected by our own banking crisis might seem questionable in the light of the Japanese case.

However, while Japan is certainly a cautionary tale, the Japanese performance has not in fact been quite as bad as it is often made out to be. Using annual data, the bursting of the bubble did not lead to an actual fall in GDP: in other words, any fall in output was swiftly made up within the year. It is true that GDP fell in 1998 and 1999, but this was hardly a direct result of the bubble bursting; it is usually associated with a temporary fiscal tightening and contagion from the Asian financial crisis. Apart from that episode post-bubble GDP grew steadily if slowly right up till the global financial crisis which began in 2008 (Chart 36). However, the growth rate of GDP has been much lower after the bubble than before (Table 12): between 1970 and 1990, GDP grew at 4.14% p.a., but between 1990 and 2007 at only 1.33% p.a. A closer look shows that this is partly due to a slower growth of employment which in turn is due to a slower growth of population (coupled with ageing). But the really striking change is the fall in hours and in hours per worker (Chart 36). In 1990, the average Japanese worker worked 2031 hours per year; by 2007 this had fallen to 1785 hours, a decline of 12%. Out of 34 countries in The Conference Board's Total Economy Database for which hours data are available, Japan came 7th in 1990 in the length of the working year. By 2007 its rank had fallen to 19th. The consequence is that the growth rate of GDP per hour worked was still a respectable 2.06% p.a. post-bubble (and a bit faster in the market sector, see Chart 2), even though down from 3.64% pre-bubble. By contrast, GDP per worker grew at only 1.30% p.a. (see Table 12 and Chart 37).[41]

[41] Curiously, neither Krugman (1998) nor Koo (2008) mentions the fall in hours worked. Nor has either anything to say about productivity, though Krugman does mention the possibility that TFP growth has fallen. By contrast, Hayashi and Prescott (2002) do discuss the fall in hours worked and cite a law of 1988 mandating a gradual cut in the workweek from 44 to 40 hours. They also dispute the credit crunch or "zombie banks" explanation for the productivity slowdown: "There is no evidence of profitable investment opportunities not being exploited due to lack of access to capital markets. The problem then and today is a low productivity growth rate." But Hayashi and Prescott offer no explanation for the fall in the TFP growth rate. Nor do they discuss fiscal policy and the possible role of rising debt in reducing the efficiency of the Japanese economy.

The fall in hours worked in Japan was certainly large. But hours worked were falling in most of these 34 countries over the same period: see Table 13. Large falls also took place in Austria, France and Germany and an even larger one in Ireland. Whatever the exact reasons for the steady decline in hours worked in the Japanese case (see Charts 36 and 38), it is difficult to associate it directly with the bursting of the bubble. It looks more like a belated adjustment to the rich country norm.

How does Japan's growth of GDP per hour compare with that of other countries? Table 14 gives the answer for the periods 1959-73, 1973-1990 and 1990-2007. In 1959-73 Japan was growing much faster than the average of these countries (8.11% p.a. versus 4.64% p.a.), in 1973-1990 its growth was again more rapid, at 3.21% p.a. compared to 1.38% p.a., but in 1990-2007 its performance was average, 2.06% p.a. versus 2.10% p.a. In the last period labour productivity in Japan was still growing more rapidly than in other large, rich countries like Canada, France, Italy and the US, though not so rapidly as in the UK. So we might interpret Japan's slowing productivity growth not as a consequence of its financial crisis but as a result of its exhausting the opportunities for catch-up.[42]

This is probably too optimistic an interpretation. Data on the growth of Japanese TFP (value added basis) are available from the EU KLEMS database, November 2009 release, for 1973-2006 (http://www.euklems.net/euk09ii.shtml). They show that for the whole economy TFP grew at 1.46% p.a. over 1973-1990 but at only 0.05% p.a. for the post-bubble period 1990-2006. The corresponding figures for manufacturing are 3.65% p.a. and 0.63% p.a. So there has been a huge slowdown in TFP growth. The sense that the Japanese economy has been malfunctioning is strengthened by looking at the real rate of return to capital in the market sector. Chart 39, also derived from the EU KLEMS database, shows this to have fallen steadily since 1990. As Koo (2008) has amply documented, the Japanese government has applied an endless series of fiscal stimuli since the bubble burst. The deleveraging undertaken by the corporate and household sectors after asset prices collapsed has been offset by huge government budget deficits. This was good in a way since it probably prevented a large rise in unemployment. It is widely believed however that much of the stimulus has gone into construction projects of dubious social value ("bridges to nowhere"). And the upshot is that Japan now has one of the highest debt-GDP ratios in the world. The gross general

[42] By 1990 Japan's GDP per capita had reached 81% of the US level (source: The Conference Board Total Economy Database, 2011 release).

government debt-to-GDP ratio rose from 68.0% in 1990 to 225.9% in 2010.[43] This may be sustainable, in the sense that the government is not about to go bust and will continue to meet its debt obligations, partly through financial repression and (perhaps) higher inflation.[44] But the high and rising debt-GDP ratio may not have been costless: it may have induced inefficiencies in capital markets which have lowered the rate of return to capital and introduced frictions into the normal process of creative destruction. Arguably, TFP growth has slowed as a result.

In summary, though the Japanese experience is not as bad as it is often portrayed, it does provide some evidence for financial crises reducing the growth rate of productivity over a lengthy period, in this case 17 years (after which of course Japanese growth has plunged still further in the wake of the world-wide financial crisis). But it may be that the way the Japanese government dealt with the crisis, by large fiscal stimuli leading to a high and still growing debt-GDP ratio, has also played a role in reducing long run growth. This may in fact be an illustration of the point made by Crafts (2013), that the *long run* effects of financial crises depend very much on how policy responds, and these responses may either promote or hinder growth (see also Broadberry and Crafts, 1992).

7 Conclusions

Before the financial crisis British growth prospects looked bright. Labour productivity was growing faster in the UK than in our major competitors and British performance on other dimensions such as inflation, employment and unemployment was good. I have presented a projection of UK labour productivity growth (output per hour), based on a two-sector model and calibrated entirely on pre-crisis data. This projection is for the market sector (i.e.

[43] Source: Reinhart-Rogoff data available at Carmen Reinhart's website (http://www.carmenreinhart.com/data/browse-by-country/countries/japan/).; accessed 19 August 2013. The net ratio was a lot lower (about 110%), but net ratios can be problematic. For example, the net ratio is much lower than the gross one in the US, one reason being that the former excludes federal government debt held by the social security fund. But the net rate also excludes the liabilities of the social security fund which are of course enormous. There was presumably a reason why the framers of the Maastricht treaty set the maximum acceptable debt-GDP ratio at 60% in gross not net terms.

[44] Hansen and Imrohoroglu (2013) argue that Japanese fiscal policy is unsustainable on its present trajectory since it would require average tax rates of the order of 40-60% in the near future (2020 onwards).

excluding government and government-financed activities like health and education). The projected figure is 2.61% p.a. About a fifth of future growth is projected to derive from the falling prices of ICT equipment from which the UK can continue to gain as a freely trading nation. The projected growth rate is a little slower than the rate actually achieved over the period 1990-2007, 2.87% p.a., mainly because I am projecting that the ICT price will fall more slowly in the future (at 5.9% p.a. rather than 8.1% p.a. as observed over 1990-2007).

The crisis has called all this into question. Not only has growth stopped but the level of labour productivity has actually fallen and is still below the level achieved during the boom. In other words five years after the recession began the recovery is still incomplete, an unprecedented situation for Britain. I have examined nine hypotheses put forward to explain the productivity puzzle. These were

1. Reallocation of labour to sectors with lower productivity
2. Excessive influence of hard-to-measure sectors
3. Mis-measurement of GDP due to mis-measurement of banking output
4. Overheating in the boom
5. Lower physical capital input
6. Lower human capital input
7. Labour/capital hoarding
8. Crippled banks and zombie firms
9. Austerity

The first four hypotheses are essentially measurement issues. I found that none of them holds water. The reallocation effects are negligible and eliminating the hard-to-measure sectors leaves the puzzle intact. Banking output may have been mis-measured but this does not mean that GDP was mis-measured. There is little evidence that demand was pressing on supply during the boom, still less that there was increasing pressure on supply. Likewise both physical and human capital per hour worked have *increased* not decreased since the recession began in 2008Q1. Similarly it is hard to blame austerity for reducing labour productivity since contrary to the common perception government expenditure on goods and services has increased, not fallen, since 2008Q1. Also the government budget has been in substantial deficit thus allowing the automatic stabilisers to play a role. All this has been accompanied by highly supportive monetary policy (with Bank Rate almost at the ZLB plus QE) and a steep fall in the exchange rate.

That leaves labour or capital hoarding and financial frictions, the latter either in the form of reduced funding to business or excessive forbearance to zombie firms. The strongest argument against labour hoarding is that it is implausible that it should continue for five years after the recession began, and also be accompanied by rising employment and hours worked since mid-2010. But the recession saw a surprisingly large fall in real wages (see Chart 29), particularly in the private sector. So labour is certainly more "affordable". The trouble is, theory suggests that more labour should be accompanied by less capital (or less of some other input) and as we have seen this didn't happen (as far as we can judge). However, it is possible that this paradox could be resolved if there was a fall in capital utilisation. Rather than labour it may be capital that is being hoarded, so that the *effective* amount of capital per unit of labour has fallen.

A related but distinct explanation (though it can't explain the whole puzzle) derives from the behaviour of intangible investment, particularly R&D, which was low in the early 2000s but held up well in the slump (Goodridge *et al*. 2013).

Turning to financial frictions, certainly bank lending to business has been reduced and this may well be part of the explanation of why business investment has fallen. But this has already been taken into account in the discussion of capital input. Keeping zombie firms alive on a financial drip may have reduced productivity but the size of this effect has yet to be quantified. In any case, in a slump loss-making firms are not necessarily low productivity firms. At the moment we lack the micro evidence to assess the strength of this hypothesis.

Arguably, all the hypotheses just summarised relate to short-term effects. So when the economy does eventually recover, what will be the long-term effect of the financial crisis? Theory suggests that banking crises can have long-lasting effects. One plausible mechanism is through a temporary interruption in TFP growth (or more broadly, innovation) which cannot be made up later. A cross-country panel analysis suggests that banking crises do indeed have long-lasting effects: they cause a fall in the long run *level* of labour productivity while leaving its long run *growth rate* unaffected. They also lead to a long run fall in the levels of capital per worker, employment and TFP. This finding corresponds to the "pessimistic" scenario of Figure 1. Unfortunately the data do not support the "optimistic" scenario. For each year of a banking crisis as defined by Reinhart and Rogoff, the long run levels of GDP per worker, capital per worker, TFP, and GDP per head are reduced by respectively 1.10%, 1.14%%, 0.81% and 1.79%. For a crisis lasting (say) five years, the reduction in levels is five times the one year effect. These are the average effects across all countries. It is true that when only developed countries are included in the analysis, the effects are smaller and less significant. But I would argue that we should not take too much comfort from this. After all, the developed countries in our sample include Greece, Ireland, Portugal and Spain. It is hard to believe that long run productivity levels in these countries will not be affected by the crisis.[45]

In the panel analysis it was just assumed that the long run growth rate was unaffected by banking crises since testing this hypothesis seemed to be asking too much of the data. So instead I took a case study approach and looked at the experience of the United States after the Great Depression of the 1930s and of Japan after the bubble burst in 1990. In the US case the long run growth rate does not seem to have been affected even though the long run GDP level took a huge hit (a 17% reduction). In the Japanese case, there was certainly a big fall in the growth rate of GDP after 1990 and up to 2007. But much of this was due to a fall in hours worked per worker. The growth rate of output per hour remained good by international standards. Nevertheless output per hour grew much less rapidly after 1990 than before, as did TFP. So there is certainly a case to be made that the bursting of the bubble reduced the long run growth rate in Japan.

So why the difference between the Japanese and US cases? The Japanese crisis was much less severe than the Great Depression: after the bubble burst Japanese GDP did not fall on an annual basis, it just grew more slowly. One possibility is the response of the Japanese government to the crisis: tight monetary policy accompanied by very lax fiscal policy. The former led to declining prices (negative inflation) over the 1990-2007 period. The latter led to a steeply rising government debt-to-GDP ratio which has now reached over 225%. I argued that the distorting effects of high debt may have led to the sharp decline in Japanese TFP growth since 1990.

In the light of all the evidence above, the following hypothesis should be considered as a topic for further research. Expansionary fiscal policy in the aftermath of a banking crisis may succeed in raising output and employment, but if it leads to excessive debt levels it will

[45] There is an interesting parallel here with the econometric evidence on the size of the fiscal multiplier in the US. Hall (2009) evidently believes that the multiplier is positive (along with most macroeconomists) and equal to about 0.5. But as Hall himself says the econometric evidence only supports a non-zero multiplier if military expenditure in the Second World War is included in the sample. A sceptic might argue that the war years are too distant in time and differ in too many other ways to be relevant. Similarly, a sceptic might argue that the experiences of Argentina, Brazil, Korea or Malaysia after financial crises are not relevant for a country like Britain ("this country is different").

reduce long term growth. So there may be a trade-off between output and employment today and growth tomorrow. Applying this argument to the UK, whether or not the UK will revert to its projected long term growth rate of GDP per hour (2.61% p.a. in the market sector) will depend on the government debt-GDP ratio not rising excessively. Even so, the cross-country evidence suggests that, assuming the banking crisis will have lasted five years and that the UK is an "average" country, the UK will suffer a permanent hit to the level of GDP per worker of about 5½% and an even larger hit to the level of GDP per capita of about 9%.

TABLES

Table 1
Output, hours, jobs and productivity in the UK in and after the Great Recession (2008Q1 = 100)

Year and quarter	*GDP*	*Hours*	*Jobs*	*GDP per hour*	*GDP per job*
2008Q1	100.00	100.00	100.00	100.00	100.00
2008Q2	99.39	99.76	100.31	99.63	99.08
2008Q3	97.93	99.34	99.84	98.58	98.09
2008Q4	95.69	99.22	99.57	96.44	96.10
2009Q1	93.30	97.49	99.15	95.70	94.10
2009Q2	92.71	97.51	98.17	95.07	94.43
2009Q3	92.67	97.02	98.16	95.52	94.41
2009Q4	92.97	98.31	98.06	94.57	94.81
2010Q1	93.54	96.20	97.63	97.23	95.81
2010Q2	94.45	98.03	98.48	96.36	95.91
2010Q3	94.95	98.13	99.08	96.76	95.83
2010Q4	94.69	98.54	98.70	96.09	95.94
2011Q1	95.07	98.56	99.27	96.46	95.77
2011Q2	95.30	97.42	99.25	97.82	96.03
2011Q3	95.91	98.21	98.78	97.66	97.09
2011Q4	95.84	98.42	98.84	97.39	96.97
2012Q1	95.85	99.13	99.68	96.69	96.15
2012Q2	95.36	99.62	100.10	95.73	95.27
2012Q3	96.09	100.75	100.42	95.37	95.68
2012Q4	95.88	101.02	101.19	94.91	94.75
2013Q1	96.11	101.28	100.71	94.89	95.44

Source: GDP from *Quarterly National Accounts June 2013*; hours and jobs from *Labour Market Statistics, July 2013*. GDP is at basic prices, chained volume measure [ONS cdid: ABMM].

Table 2
Projected growth rates of GDP per hour for the UK market sector derived from one-sector and two-sector models
(parameters values calibrated on pre-crisis data)

Description	*Parameter*	*Method*	*Value*
TFP growth rate (whole economy)	$\Delta \ln \bar{B}$	Mean, 1990-2007	0.0114
TFP growth rate (consumption sector)	$\Delta \ln \bar{B}_C$	Mean, 1990-2007	0.0087
ICT income share	$\bar{v}_{K_{ICT}}$	HP trend	0.0641
ICT output share	$\bar{w}_{ICT}$	HP trend	0.0183
Labour share	$\bar{v}_L$	Mean, 1990-2007	0.7301
Rate of decline of ICT price	$\Delta \ln \bar{p}$	HP trend	-0.0590
Growth rate of skill	$\bar{g}_h$	Mean, 1990-2007	0.0057
Projected growth rates of GDP per hour			
One-sector model	$\Delta \ln \bar{y}$		0.0213
Two-sector model	$\Delta \ln \bar{y}$		0.0261

Source Parameter values derived from pre-crisis UK data in EU KLEMS (November 2009 release, available at www.euklems.net). Rate of decline of relative price of ICT ($\Delta \ln \bar{p}$) from pre-crisis data from U.S. NIPA (www.bea.gov). Projected growth rates derived using equations (4) and (20). See text for details.

Table 3
Sectoral breakdown of the UK economy in 2007

SECTOR		*Share of GDP, %*	*Share of total hours, %*	*Relative product-ivity, ratio*
A	***Agriculture, forestry & fishing***	0.6	1.6	0.39
B	***Mining & quarrying inc. oil & gas***	2.5	0.3	10.65
C	Manufacturing	11.1	10.9	1.01
D	Electricity, gas, steam, etc	1.3	0.4	2.93
E	Water supply, sewerage, etc	1.1	0.5	2.19
F	Construction	7.7	8.4	0.91
G	Wholesale & retail trade	11.5	15.0	0.76
H	Transport & storage	4.8	5.3	0.91
I	Accommodation & food services	2.9	5.4	0.54
J	Information & communication	6.0	4.3	1.34
K	***Financial & insurance activities***	8.3	4.1	2.07
L	***Real estate***	8.7	1.4	6.37
M	Professional, scientific & tech. activities	7.3	7.5	0.96
N	Administrative & support activities	4.5	7.5	0.59
O,P,Q	***Government services***	18.4	22.7	0.81
R	Arts, entertainment & recreation	1.5	2.2	0.67
S-U	Other services & household activities	1.8	2.4	0.72
	TOTAL	100.0	100.0	1.00

Source Office for National Statistics.
Note Classification is in accordance with SIC 2007. Relative productivity is GDP share divided by hours share. Sectors in ***Bold Italic*** are those described in the text as “problematic” for various reasons. Output of Real estate includes the imputed rent of owner-occupiers. Government services include Public Administration and defence, Education, and Health and social services. Relative productivity is GDP share divided by hours share, i.e. value added per hour in the sector in question divided by value added per hour in the whole economy.

Table 4
Estimates of labour productivity (GVA per hour) for broad sectors: ratio of GDP per hour in (a) the trough of the recession (2009Q3) and (b) the latest period (2013Q1) to GDP per hour in the previous peak (2008Q1=100.0)

	GDP	*Market sector (GDP exc. O, P and Q)*	*Market sector, exc. problematic sectors (A, B and K)*	*GDP, holding labour shares at 2007 values*
Ratios	(1)	(2)	(3)	(4)
Trough (2009Q3) to peak (2008Q1)	95.52	95.31	94.54	95.89
Latest period (2013Q1) to peak (2008Q1)	94.89	94.93	96.23	94.19

Source Office for National Statistics. Column (1) from Table 1; columns (2)–(4) from data underlying the *Productivity Bulletin, June-July 2013*. See text for further explanation.

Table 5
Indicators of demand pressure in the UK, 2000Q1-2013Q1

Year and quarter	*Growth of GDP deflator*	*Net exports/GDP*	*Unemployment rate*	*Employment rate, 16-64*
	% per quarter	*%*	*%*	*%*
2000Q1	0.29	-1.64	5.8	72.3
2000Q2	-1.55	-1.72	5.5	72.5
2000Q3	1.09	-2.29	5.3	72.6
2000Q4	0.61	-1.75	5.2	72.5
2001Q1	0.91	-1.68	5.1	72.6
2001Q2	0.92	-2.43	5.0	72.7
2001Q3	1.40	-2.63	5.1	72.5
2001Q4	0.27	-2.29	5.2	72.6
2002Q1	0.92	-2.92	5.2	72.5
2002Q2	0.43	-2.63	5.2	72.7
2002Q3	0.86	-2.46	5.3	72.6
2002Q4	0.39	-2.83	5.1	72.9
2003Q1	1.01	-2.16	5.2	72.7
2003Q2	-0.04	-2.07	4.9	72.9
2003Q3	0.44	-2.31	5.1	72.8
2003Q4	0.45	-2.49	4.9	72.7
2004Q1	0.10	-2.60	4.8	73.0
2004Q2	1.44	-2.84	4.8	72.9
2004Q3	1.05	-2.80	4.7	72.8
2004Q4	0.60	-2.63	4.7	73.0
2005Q1	-0.07	-2.96	4.7	73.0
2005Q2	0.63	-2.59	4.8	72.9
2005Q3	-0.33	-3.05	4.8	73.0
2005Q4	0.71	-2.56	5.2	72.6
2006Q1	1.43	-2.56	5.3	72.9
2006Q2	0.75	-2.23	5.5	72.8
2006Q3	0.28	-2.91	5.5	72.8
2006Q4	1.08	-2.73	5.5	72.7
2007Q1	0.08	-2.79	5.5	72.5
2007Q2	0.67	-2.10	5.4	72.6
2007Q3	0.65	-2.61	5.3	72.6
2007Q4	0.67	-2.78	5.2	72.9
2008Q1	1.83	-2.80	5.2	73.0
2008Q2	-0.44	-2.28	5.4	72.9
2008Q3	1.00	-2.34	5.9	72.4
2008Q4	1.92	-1.47	6.4	72.1
2009Q1	0.62	-1.90	7.1	71.7
2009Q2	-0.15	-1.88	7.8	70.9
2009Q3	1.36	-1.30	7.9	70.6
2009Q4	0.40	-1.52	7.8	70.6
2010Q1	0.94	-1.98	8.0	70.2
2010Q2	-0.58	-1.81	7.9	70.4
2010Q3	1.11	-2.48	7.7	70.8
2010Q4	0.23	-2.57	7.8	70.5
2011Q1	0.21	-0.42	7.8	70.7
2011Q2	0.19	-2.14	7.9	70.6
2011Q3	0.77	-2.11	8.3	70.2
2011Q4	-0.18	-1.38	8.4	70.4

Table 5, continued

2012Q1	0.69	-2.17	8.2	70.6
2012Q2	0.09	-2.57	8.0	71.0
2012Q3	0.28	-1.85	7.8	71.2
2012Q4	0.61	-2.10	7.8	71.6
2013Q1	0.97	-1.54	7.8	71.4

Source GDP deflator at basic prices [ABML/ABMM and net exports (exports minus imports) as a proportion of GDP at market prices [IKBJ/YBHA] from *Quarterly National Accounts June 2013*]; unemployment rate [MGSX] and employment rate [LF24] from *Labour Force Statistics, July 2013*.

Table 6
Estimates of capital per hour in the UK market sector in and after the Great Recession: ratio of current level to previous peak in 2007Q4 (2007Q4=100.00)

	Based on old (pre-July 2013) series for NPEL			*Based on new(July 2013) series for NPEL*		
	Quarterly depreciation rate			*Quarterly depreciation rate*		
Year and quarter	*0.02063*	*0.01535*	*0.025996*	*0.02063*	*0.01535*	*0.025996*
2007Q4	100.00	100.00	100.00	100.00	100.00	100.00
2008Q1	98.63	98.62	98.63	98.86	98.81	98.91
2008Q2	101.23	101.21	101.23	101.58	101.50	101.65
2008Q3	102.19	102.20	102.18	102.37	102.34	102.39
2008Q4	104.30	104.34	104.25	104.12	104.19	104.04
2009Q1	107.05	107.15	106.93	106.42	106.63	106.19
2009Q2	108.01	108.21	107.79	107.61	107.87	107.32
2009Q3	108.56	108.88	108.22	108.01	108.42	107.58
2009Q4	108.64	109.09	108.18	108.10	108.63	107.55
2010Q1	109.69	110.23	109.13	109.16	109.77	108.52
2010Q2	108.57	109.22	107.91	107.94	108.68	107.18
2010Q3	108.17	108.91	107.41	107.45	108.30	106.58
2010Q4	107.59	108.43	106.74	106.70	107.67	105.71
2011Q1	108.19	109.15	107.23	107.03	108.16	105.89
2011Q2	109.35	110.40	108.29	108.10	109.34	106.86
2011Q3	108.85	109.98	107.73	107.45	108.78	106.13
2011Q4	108.78	109.97	107.60	107.14	108.57	105.72
2012Q1	108.67	109.93	107.43	107.06	108.57	105.58
2012Q2	108.44	109.76	107.16	106.51	108.10	104.95
2012Q3	107.55	108.91	106.22	105.40	107.07	103.77
2012Q4	107.74	109.18	106.36	105.06	106.87	103.30
2013Q1	..	..	..	104.46	106.42	102.58

Notes Capital stock estimated by the Perpetual Inventory Method applied to quarterly Business investment (CVM; ONS cdid: NPEL), 1987Q1-2012Q4 (old series) or 1987Q1-2013Q1 (new series). The initial capital stock is estimated by an iterative method: see text for details. Market sector hours are from an ONS spreadsheet underlying the *Productivity Bulletin*. The quarterly depreciation rates of 0.02063, 0.01535 and 0.025996 correspond to annual rates of respectively 8%, 6% and 10%.

Table 7
Real average weekly earnings, 2008Q1=100.0

	Private sector	*Public sector*	*Whole economy*
2008Q1	100.0	100.0	100.0
2008Q2	99.2	101.1	99.6
2008Q3	98.4	100.9	99.0
2008Q4	96.8	99.7	97.4
2009Q1	92.8	99.7	94.3
2009Q2	96.4	100.8	97.3
2009Q3	94.5	100.5	95.8
2009Q4	94.8	101.1	96.3
2010Q1	94.4	100.9	95.7
2010Q2	94.6	102.2	96.3
2010Q3	94.5	101.6	96.0
2010Q4	94.8	102.1	96.4
2011Q1	95.8	103.1	97.4
2011Q2	95.7	102.9	97.4
2011Q3	95.4	102.6	96.8
2011Q4	95.9	102.8	97.3
2012Q1	95.1	102.5	96.8
2012Q2	96.3	103.0	97.5
2012Q3	96.4	103.9	97.8
2012Q4	95.6	103.1	97.0
2013Q1	93.4	101.9	95.6

Note: Average weekly earnings (seasonally adjusted monthly data, converted to quarterly) deflated by GDP deflator.
Sources: Average weekly earnings from *Labour Market Statistics, July 2013*;
GDP deflator from *Quarterly National Accounts, June 2013* (at basic prices, calculated as ABML/ABMM).

Table 8
Employment in the public and private sectors

		Public sector (000's)	(%)	*Private sector* (000's)	(%)	*Total* (000's)
2008	Mar	6,010	20.4	23,518	79.6	29,528
	Jun	6,026	20.4	23,482	79.6	29,508
	Sep	6,066	20.7	23,280	79.3	29,346
	Dec	6,325	21.6	23,003	78.4	29,328
2009	Mar	6,319	21.7	22,759	78.3	29,078
	Jun	6,323	21.9	22,508	78.1	28,831
	Sep	6,365	22.0	22,520	78.0	28,885
	Dec	6,362	22.1	22,481	77.9	28,843
2010	Mar	6,328	21.9	22,514	78.1	28,842
	Jun	6,311	21.7	22,807	78.3	29,118
	Sep	6,266	21.5	22,843	78.5	29,109
	Dec	6,221	21.3	22,946	78.7	29,167
2011	Mar	6,196	21.2	23,032	78.8	29,228
	Jun	6,102	20.9	23,028	79.1	29,130
	Sep	6,069	20.9	23,033	79.1	29,102
	Dec	6,035	20.7	23,106	79.3	29,141
2012	Mar	5,999	20.5	23,325	79.5	29,324
	Jun	5,769	19.5	23,791	80.5	29,560
	Sep	5,742	19.4	23,859	80.6	29,601
	Dec	5,722	19.2	24,010	80.8	29,732

Source Office for National Statistics, available online as emp02mar2013_tcm77-301480.xls.
Note Employees in Lloyds-HBOS and Royal Bank of Scotland transferred from private to public sector in October 2008. 196,000 employees in Further Education Corporations and Sixth Form Colleges Corporations transferred from public to private sector between March and June 2012.

Table 9
Real government expenditure on goods and services: official versus Keynesian measures (2008Q1=100.00)

	Official			*Keynesian*	
Year and quarter	*CVM*	*CVM*	*CVM*	*Deflated by GDP deflator*	*Deflated by wage index (AWE)*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	Current	*Capital*	*Total*	*Total*	*Total*
2008Q1	100.00	100.00	100.00	100.00	100.00
2008Q2	100.41	99.08	100.29	99.62	100.62
2008Q3	101.27	98.72	101.02	100.15	101.14
2008Q4	102.49	100.67	102.31	101.98	104.19
2009Q1	101.57	111.50	102.55	103.90	108.79
2009Q2	101.29	103.63	101.54	101.66	103.43
2009Q3	101.97	116.02	103.41	104.23	107.99
2009Q4	102.29	120.73	104.14	103.32	106.78
2010Q1	101.99	115.73	103.42	102.80	107.34
2010Q2	102.49	108.50	103.24	101.85	105.86
2010Q3	102.37	112.87	103.55	101.21	105.48
2010Q4	102.29	110.36	103.24	101.47	105.53
2011Q1	102.23	110.39	103.19	102.48	106.17
2011Q2	102.39	95.67	101.99	97.18	100.73
2011Q3	101.94	100.56	102.10	97.47	101.97
2011Q4	102.38	95.73	102.01	97.99	102.05
2012Q1	105.15	107.55	105.73	101.93	106.62
2012Q2	104.19	109.10	105.01	96.68	100.17
2012Q3	105.08	99.13	104.89	97.73	101.09
2012Q4	105.90	101.52	105.87	98.26	102.90
2013Q1	106.01	95.45	105.35	97.87	103.71

Source Government current spending (central and local government), nominal and real, and GDP deflator (at market prices, YBHA/ABMI) from *Quarterly National Accounts*, *June 2013*. Government investment, nominal and real, from corrected figures in *Business investment, Q1-2013 results* (Office for National Statistics 2013b). The "total official" measure is my own calculation and is a chained-linked Laspeyres index of the official current and capital expenditure series. Average weekly earnings index from Office for National Statistics (2013a).

Table 10
Mean net lending by sector as % of GDP

	2000Q1-2008Q1	*2008Q2-2013Q1*
Government	-1.69	-8.01
Corporations	2.17	5.29
Households	-2.50	0.61
Rest of world	2.02	2.00

Source: ONS, *Quarterly National Accounts*, *June 2013*. GDP is at market prices. Government is central and local government combined.

Table 11
Long run percentage effects on levels of GDP per worker, capital per worker, TFP, and GDP per capita of one year spent in a Reinhart-Rogoff banking crisis
(estimates of θ derived from equation (29), estimated by Arellano-Bond (difference) method; standard errors in parentheses)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable affected by crisis	All countries and years	Exc. Great Recession	Exc. Asia	Exc. Latin America	Developed countries only	Developing countries only	1950-79	1980-2010
GDP per worker								
100 x θ	-1.096***	-1.005***	-1.112***	-0.550	0.362	-1.258***	0.831	-1.231***
(s.e.)	(0.356)	(0.380)	(0.417)	(0.382)	(0.278)	(0.467)	(1.954)	(0.382)
Capital per worker								
100 x θ	-1.137***	-1.419***	-0.997**	-0.755*	-0.0423	-1.677***	-0.832	-1.229***
(s.e.)	(0.411)	(0.462)	(0.405)	(0.392)	(0.379)	(0.397)	(1.122)	(0.418)
TFP								
100 x θ	-0.813**	-0.718**	-0.807**	-0.373	0.394	-0.864**	1.019	-0.854**
(s.e.)	(0.340)	(0.341)	(0.379)	(0.329)	(0.288)	(0.437)	(1.916)	(0.358)
GDP per capita								
100 x θ	-1.794***	-1.574***	-1.849***	-1.444***	-0.789**	-1.773***	0.390	-1.875***
(s.e.)	(0.372)	(0.386)	(0.406)	(0.396)	(0.386)	(0.495)	(2.170)	(0.410)

Note *** p<0.01, ** p<0.05, * p<0.1. Standard error for θ estimated by Stata's *nlcom* procedure. Fixed effects, year dummies and constant included in all regressions. In the full sample ("All countries and years") the number of countries is 61, the period is 1950-2010 (61 years) and the total number of observations is 3277; 23 countries are classified as developed and 38 as developing. For full details of estimation results, data sources and methods, see Oulton and Sebastiá-Barriel (2013). The data used to produce these results can be found at: http://www.bankofengland.co.uk/publications/Pages/workingpapers/2013/wp470.aspx.

Table 12
Japan: average annual growth rates before and after the bubble, % p.a.

	1970-1990	*1990-2007*
GDP	4.14	1.33
Population	0.84	0.18
Employment	0.87	0.02
Hours	0.51	-0.74
GDP per head	3.30	1.15
GDP per worker	3.27	1.30
GDP per hour	3.64	2.06

Source: The Conference Board, Total Economy Database, 2011 release. (http://www.conference-board.org/data/economydatabase).

Table 13
Hours worked per worker per year (number):
34 countries, 1990 and 2007

Country	*1990*	*2007*	*% change*
Argentina	1850	1841	-0.5
Austria	1832	1678	-8.4
Belgium	1652	1560	-5.6
Brazil	1879	1841	-2.0
Canada	1788	1735	-3.0
Chile	1984	2168	9.3
Colombia	1969	1956	-0.7
Denmark	1525	1547	1.4
Finland	1769	1706	-3.6
France	1705	1556	-8.7
Germany	1572	1430	-9.0
Greece	2233	2115	-5.3
Hungary	1945	1985	2.1
Iceland	1839	1808	-1.7
Ireland	2179	1869	-14.2
Italy	1867	1816	-2.7
Japan	**2031**	**1785**	**-12.1**
Mexico	2121	2177	2.6
Netherlands	1508	1389	-7.9
New Zealand	1759	1704	-3.1
Norway	1502	1419	-5.5
Peru	1930	1926	-0.2
Poland	1750	2078	18.7
Portugal	1839	1942	5.6
Romania	1638	1878	14.7
Singapore	2318	2307	-0.5
Spain	1742	1636	-6.1
Sweden	1561	1618	3.7
Switzerland	1700	1643	-3.4
Taiwan	2364	2166	-8.4
Turkey	2057	1918	-6.8
United Kingdom	1783	1673	-6.2
United States	1724	1709	-0.9
Venezuela	1889	1931	2.2
Mean	*1847*	*1809*	*-1.9*

Source: The Conference Board, Total Economy Database, 2011 release. (http://www.conference-board.org/data/economydatabase).

Table 14
Growth rate of GDP per hour:
34 countries, 1959-2007% p.a.

Country	*1959-73*	*1973-90*	*1990-2007*
Argentina	3.42	-0.73	2.80
Austria	6.02	2.45	2.11
Belgium	5.84	2.57	1.65
Brazil	3.39	1.37	1.27
Canada	2.10	1.05	1.42
Chile	2.53	0.41	2.17
Colombia	2.88	1.33	1.27
Denmark	3.74	2.31	1.53
Finland	5.15	2.95	2.72
France	5.42	3.07	1.75
Germany	5.25	2.98	1.95
Greece	7.96	2.00	2.30
Hungary	..	1.73	3.06
Iceland	4.27	2.44	1.90
Ireland	5.04	4.01	3.68
Italy	7.22	2.40	0.92
Japan	**8.11**	**3.21**	**2.06**
Mexico	3.47	-0.47	0.80
Netherlands	5.47	2.29	1.65
New Zealand	2.06	-0.14	1.17
Norway	4.61	3.06	2.18
Peru	3.85	-2.67	2.96
Poland	..	-3.76	3.16
Portugal	7.15	1.77	1.26
Romania	..	-9.56	2.99
Singapore	6.36	3.26	2.52
Spain	6.60	4.04	1.14
Sweden	4.36	0.97	2.29
Switzerland	3.51	1.12	1.05
Taiwan	6.49	6.04	4.48
Turkey	4.64	3.80	3.86
United Kingdom	3.48	2.20	2.87
United States	2.49	1.25	1.83
Venezuela	1.08	-1.79	0.73
Mean	*4.64*	*1.38*	*2.10*

Source: The Conference Board, Total Economy Database, 2011 release. (http://www.conference-board.org/data/economydatabase).

FIGURES AND CHARTS

Figure 1
Hypothetical paths for GDP per hour during recession and recovery

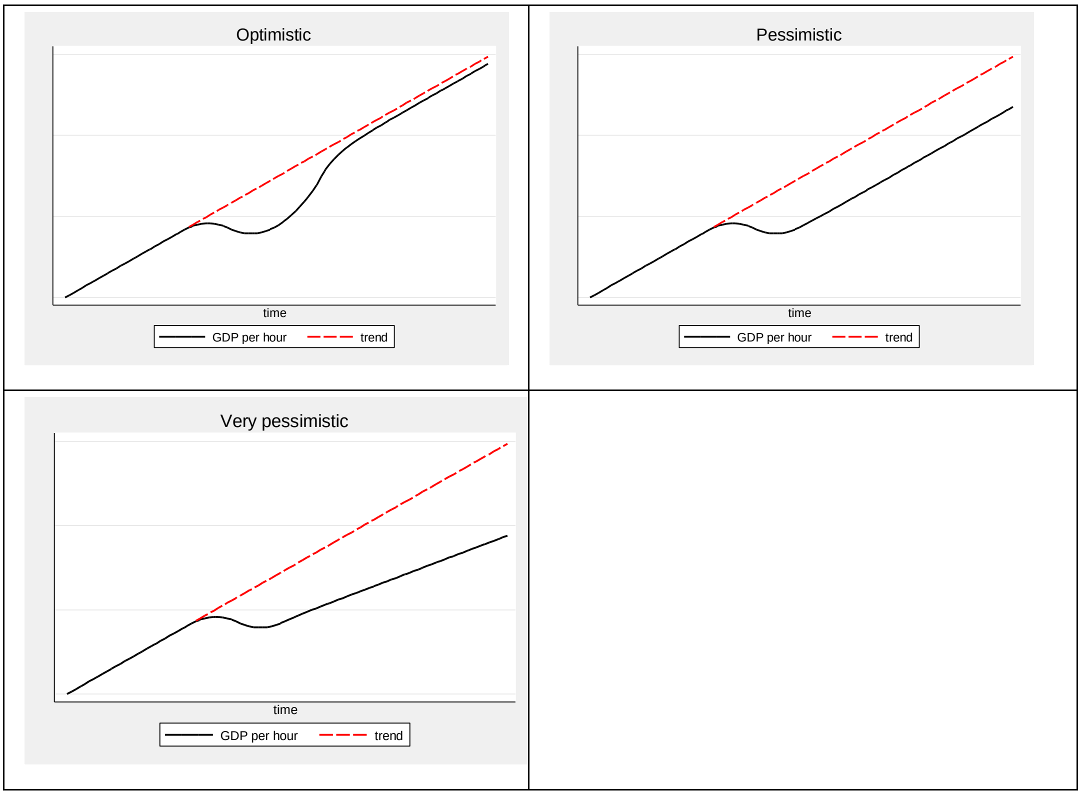
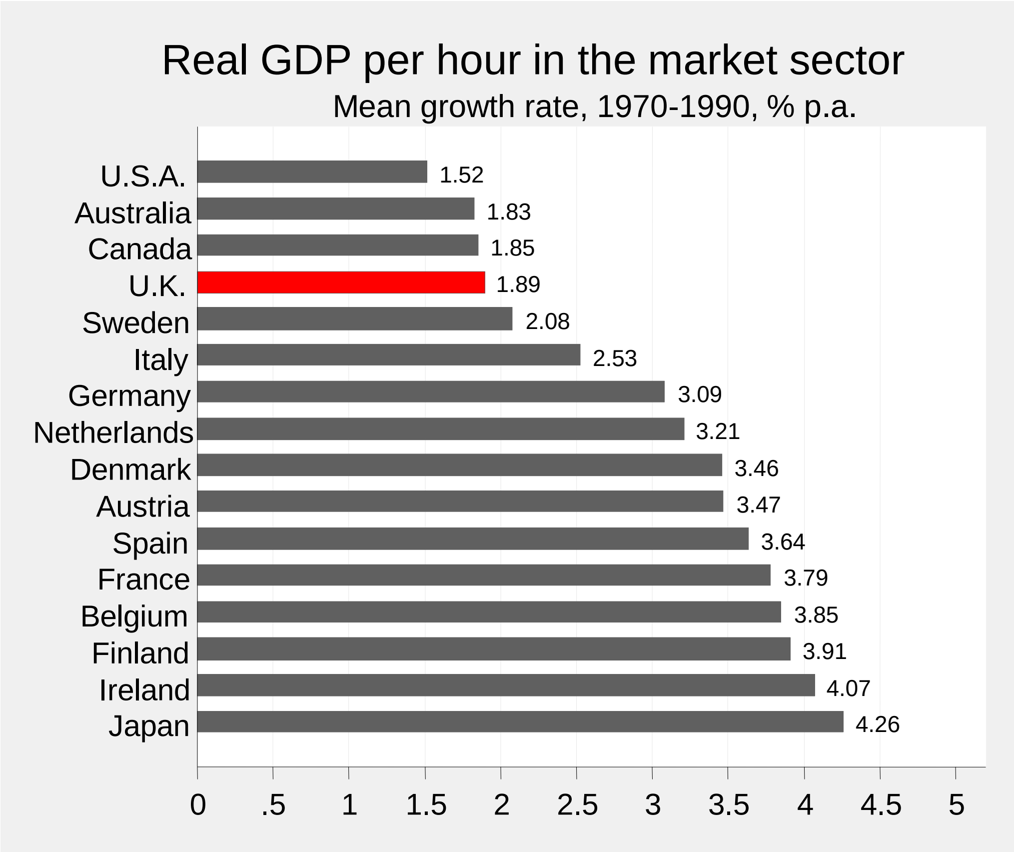


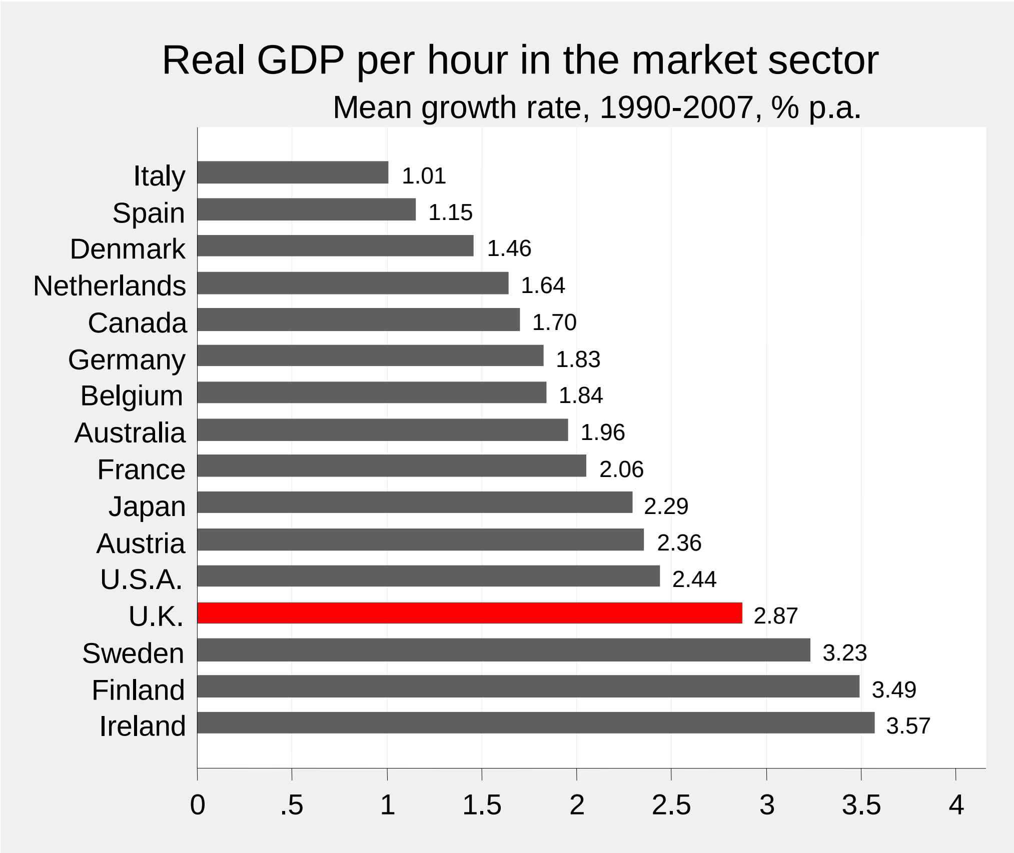
Chart 1



4

Source EU KLEMS, November 2009 release (www.euklems.net).

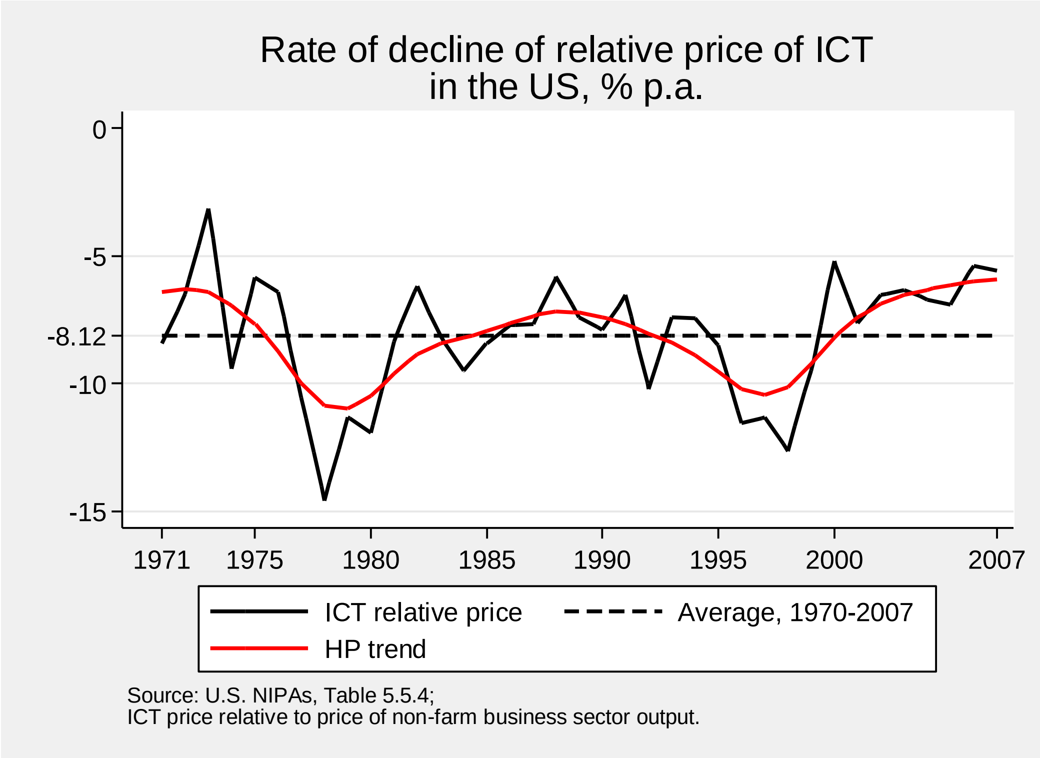
Chart 2



5

Source EU KLEMS, November 2009 release (www.euklems.net).

Chart 3



Rate of decline of relative price of ICT
in the US, % p.a.
0
-5
-8.12
-10
-15
1971
1975
1980
1985
1990
1995
2000
2007
ICT relative price
Average, 1970-2007
HP trend
Source: U.S. NIPAs, Table 5.5.4;
ICT price relative to price of non-farm business sector output.

Chart 4

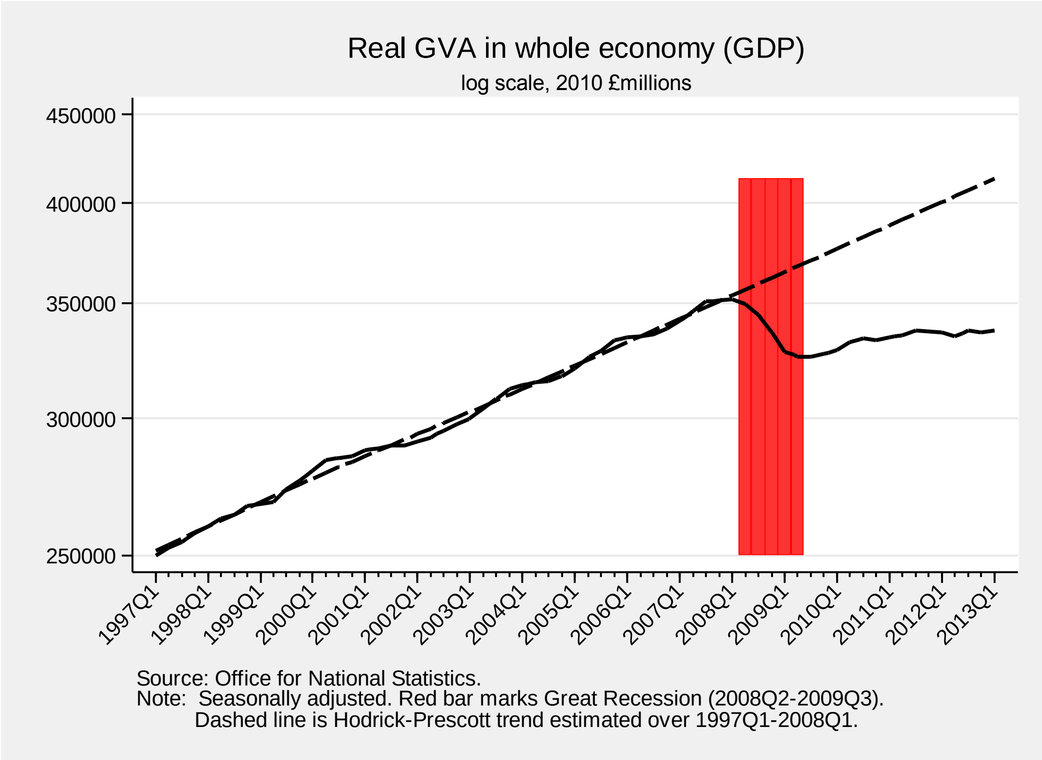


Chart 5

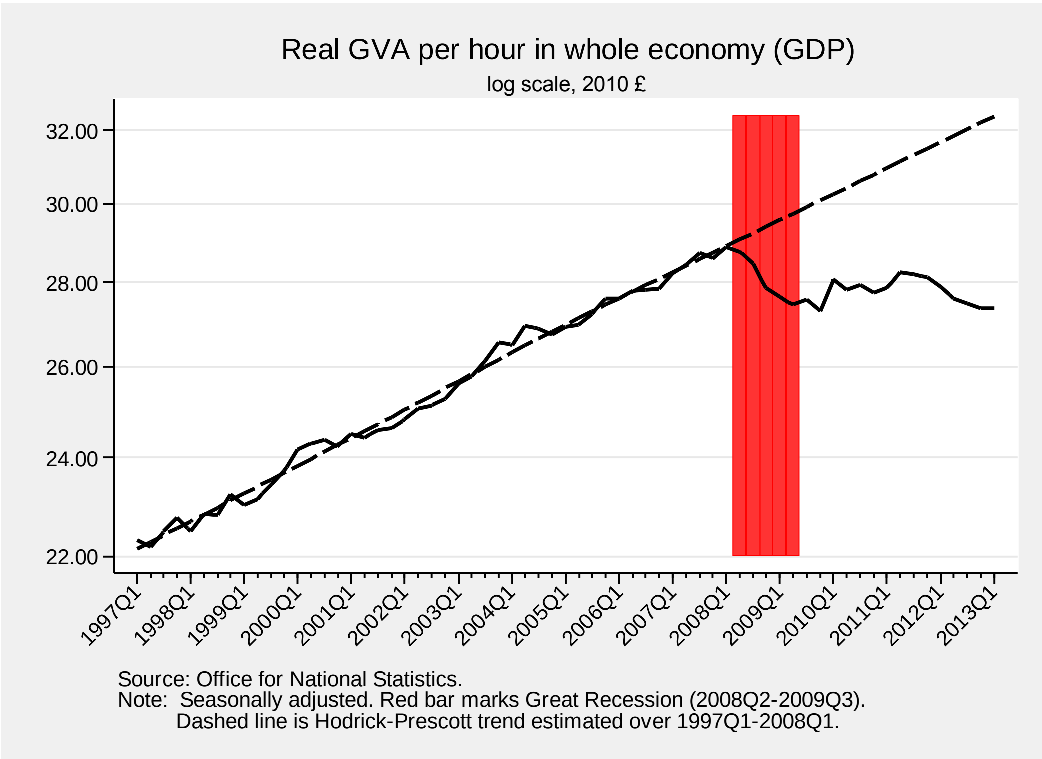


Chart 6

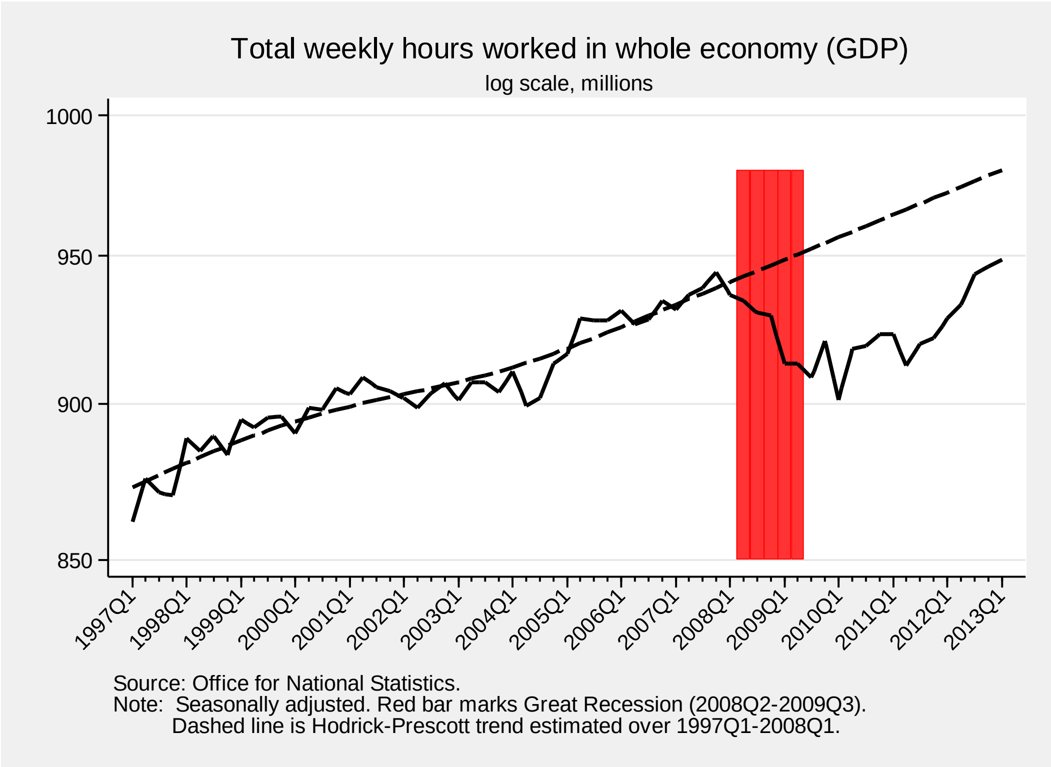


Chart 7

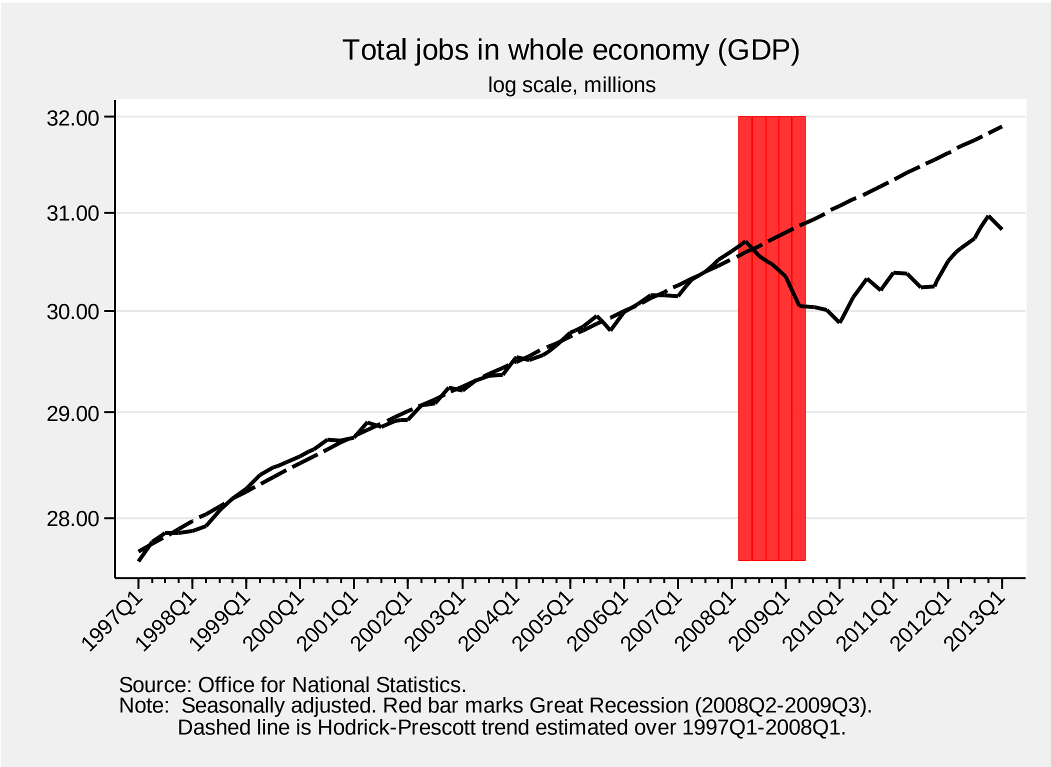


Chart 8

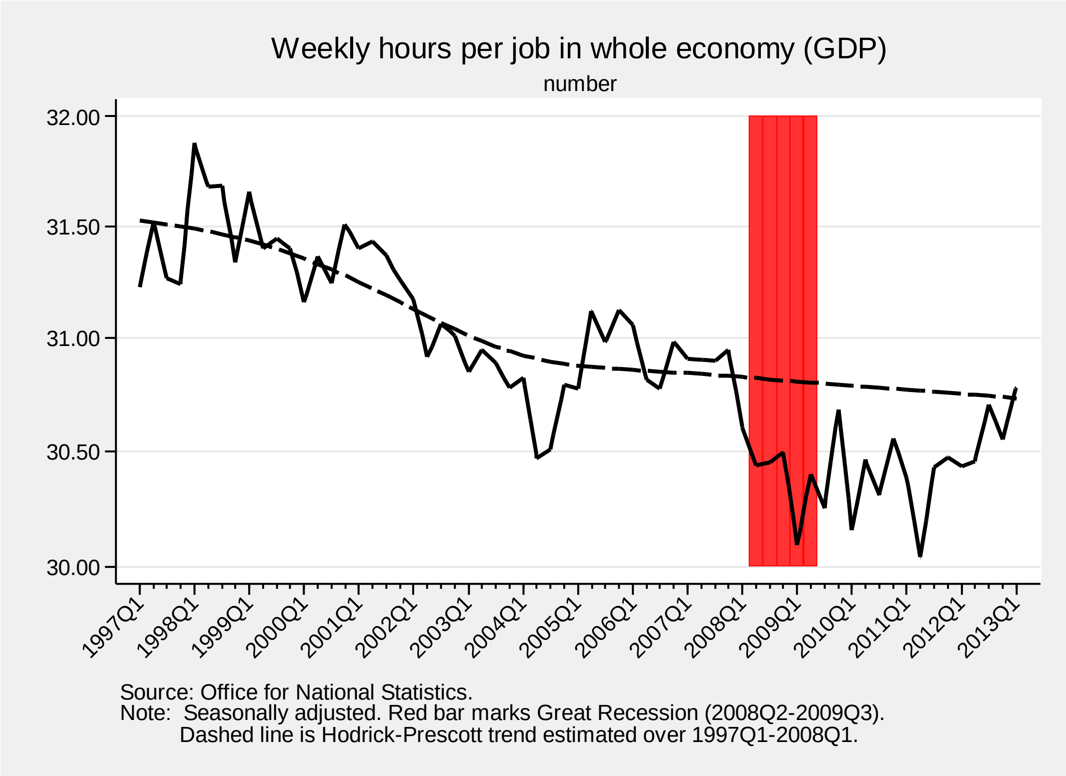


Chart 9

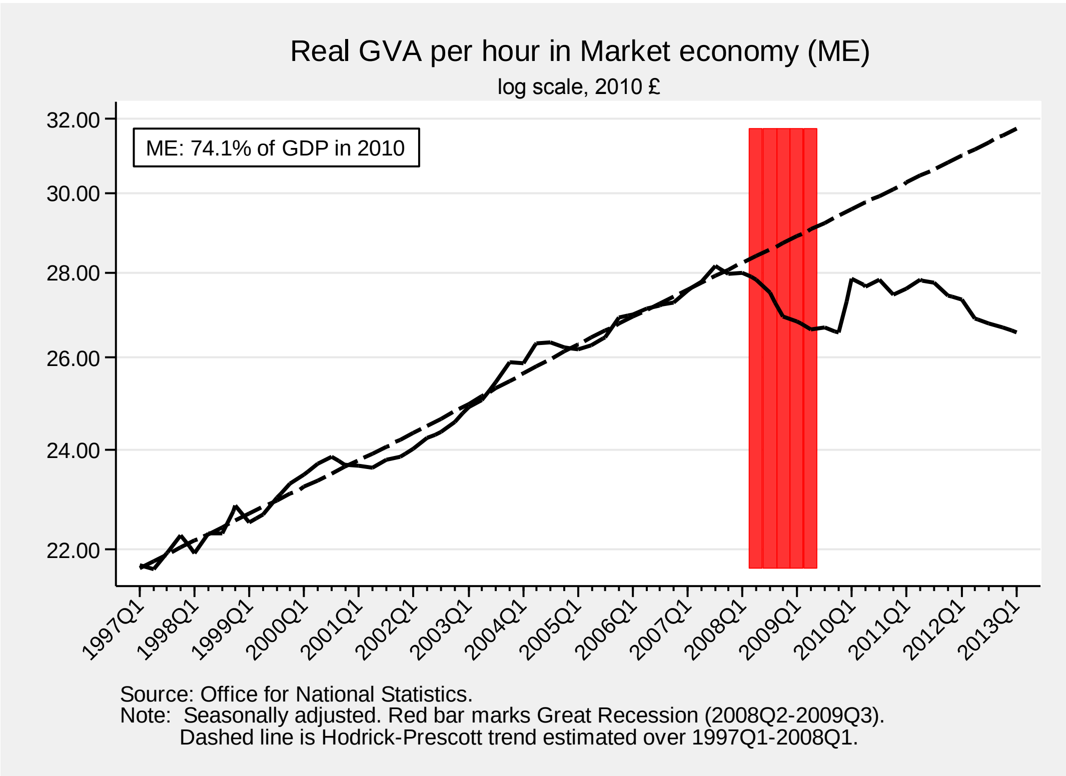
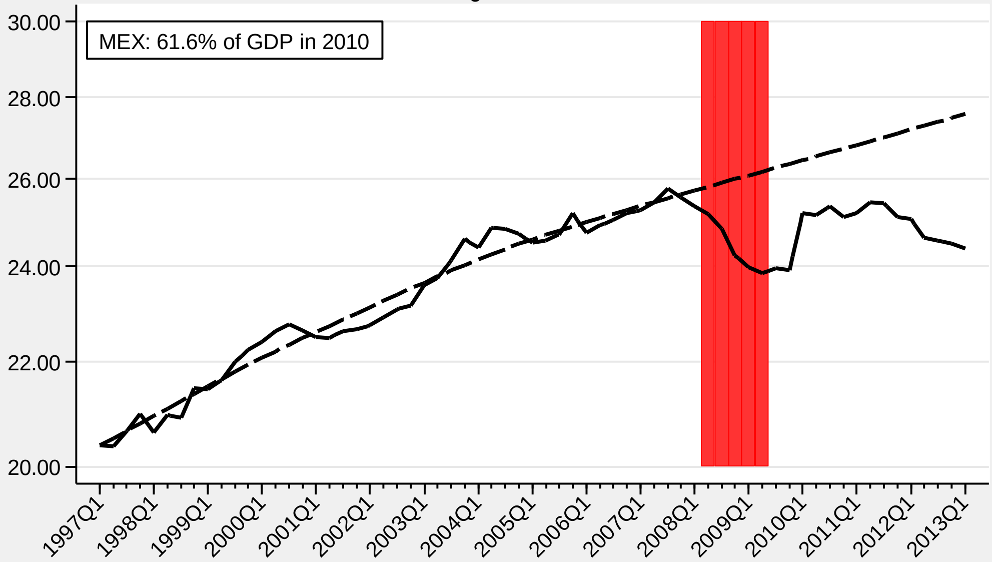


Chart 10

Real GVA per hour in Market economy, exc. A,B & K (MEX)

log scale, 2010 £

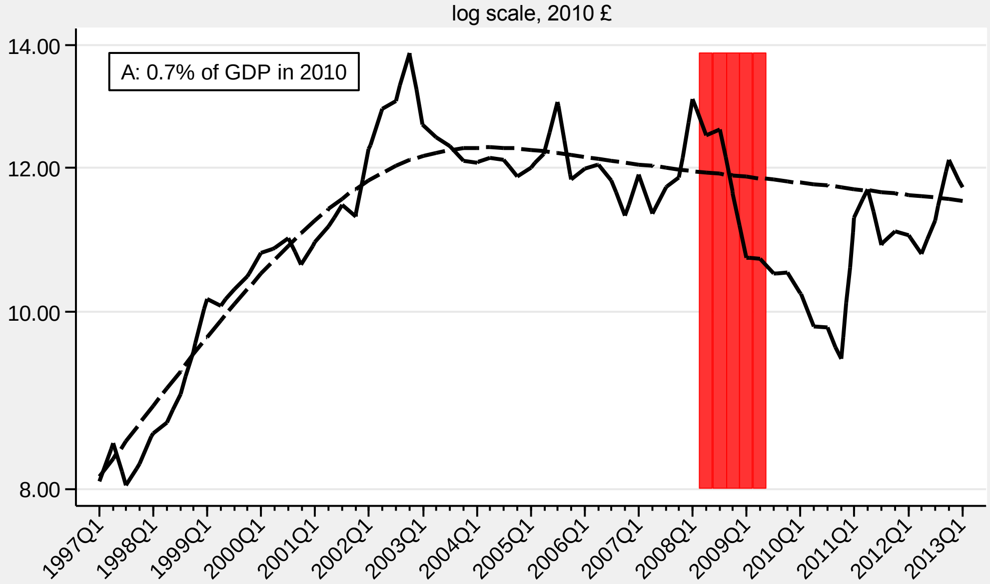


Source: Office for National Statistics.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

Chart 11

Real GVA per hour in Agriculture (A)

log scale, 2010 £



Source: Office for National Statistics.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

Chart 12

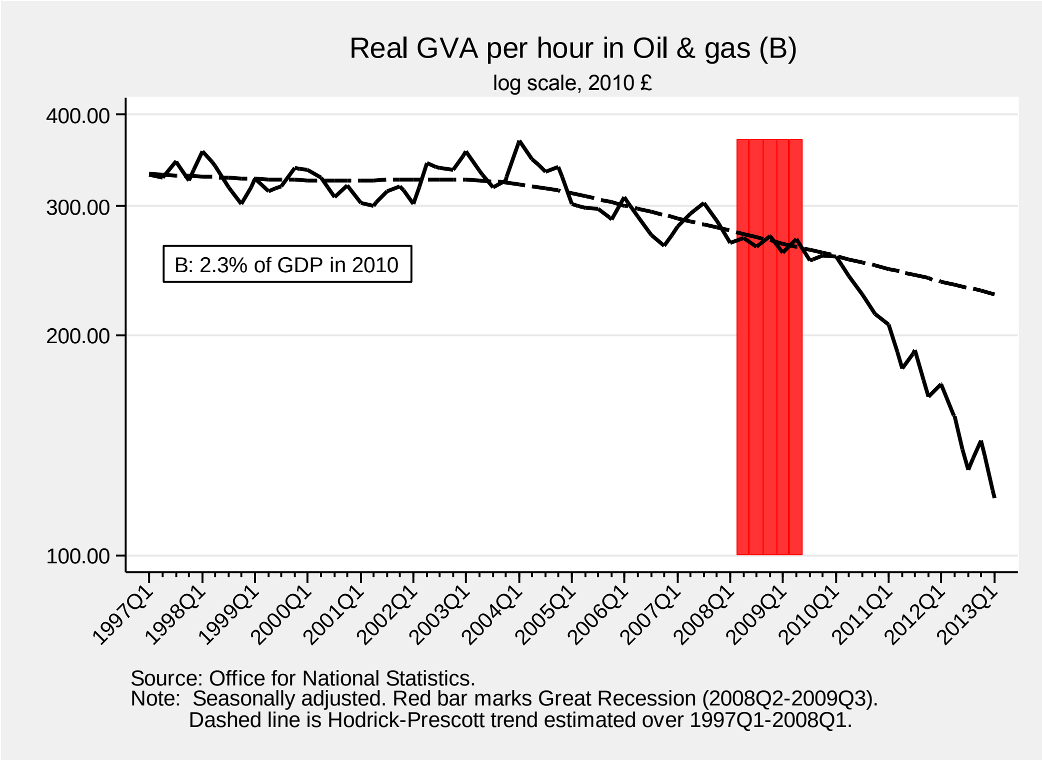


Chart 13

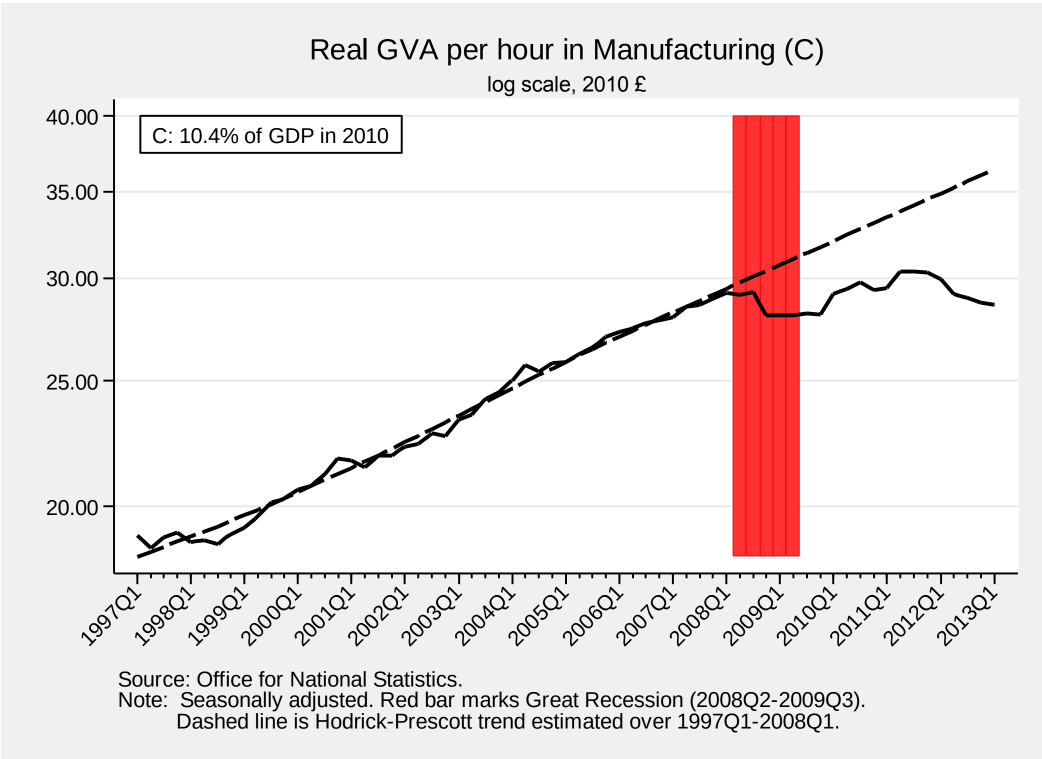


Chart 14

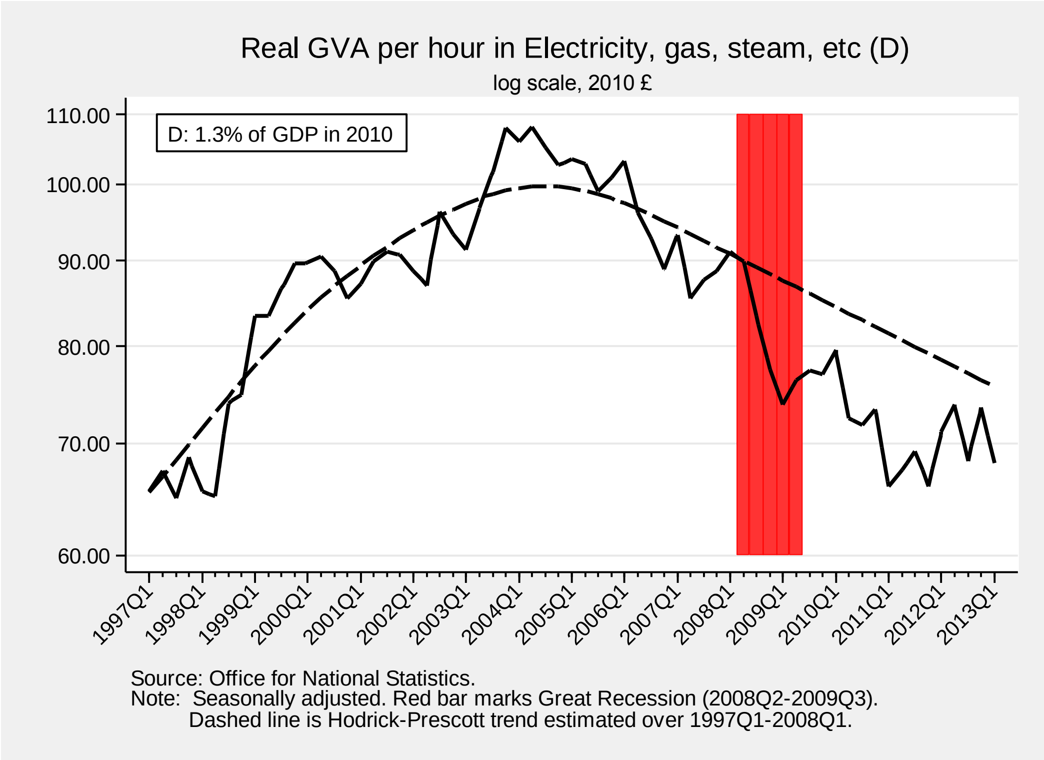


Chart 15

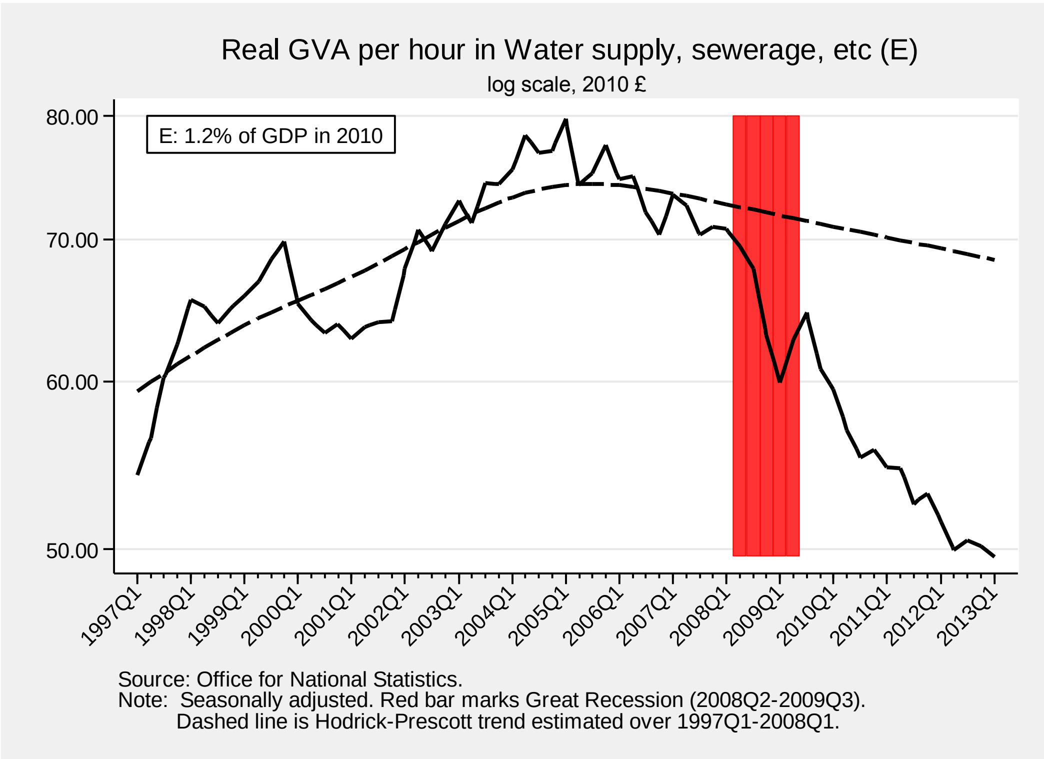
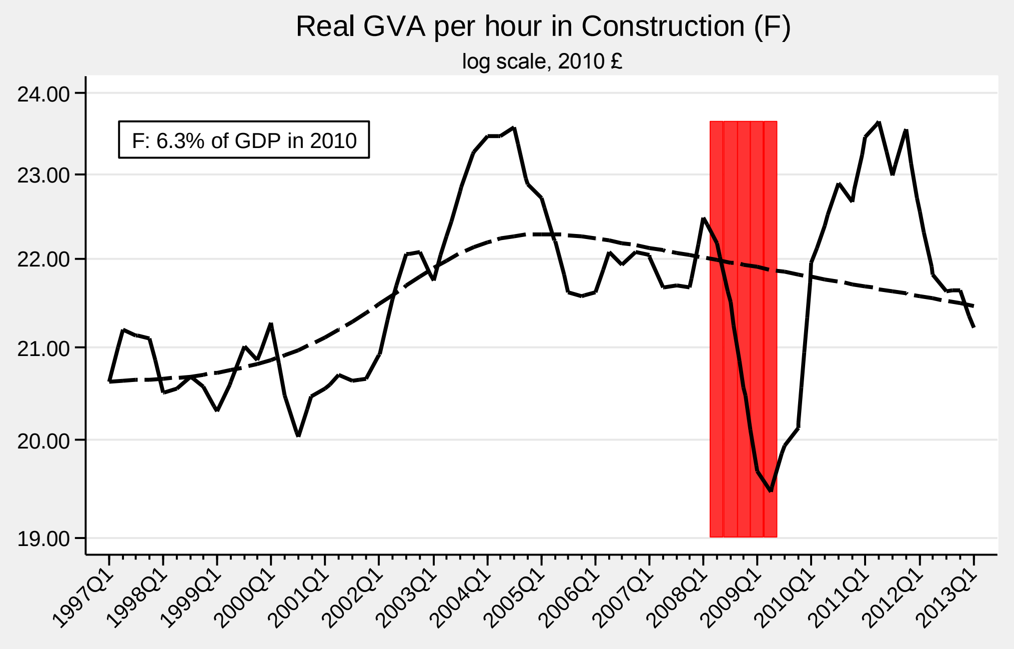


Chart 16

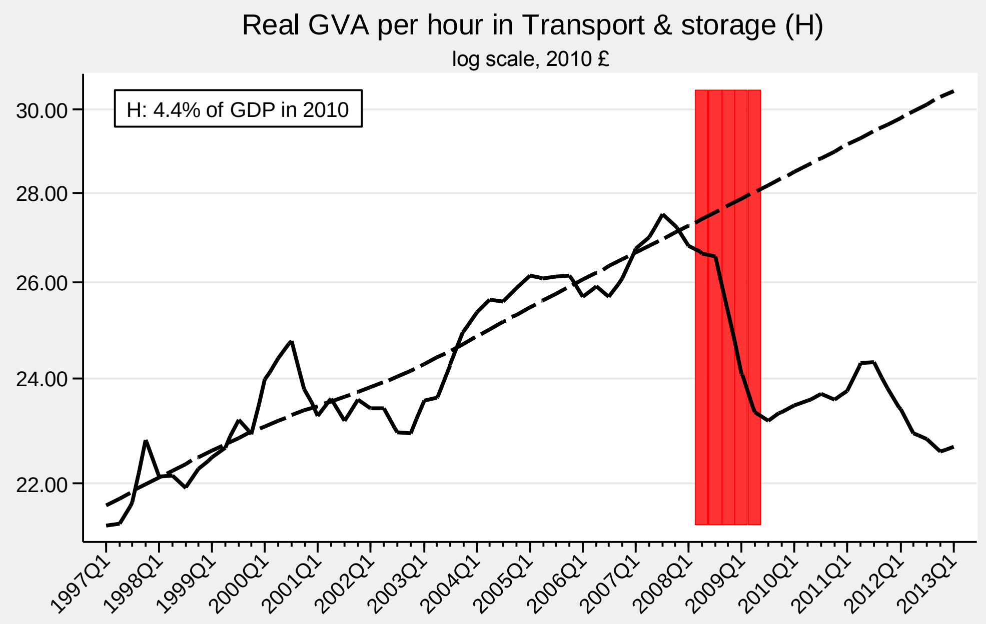


Source: Office for National Statistics.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

Chart 17

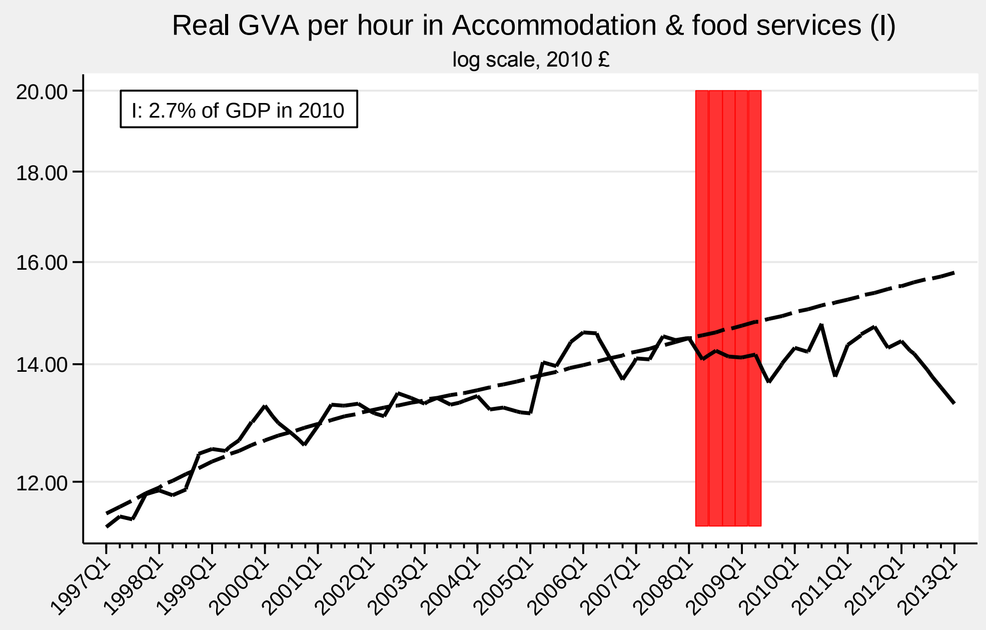
Source: Office for National Statistics.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

Chart 18



Source: Office for National Statistics.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

Chart 19



Source: Office for National Statistics.
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q3).
Dashed line is Hodrick-Prescott trend estimated over 1997Q1-2008Q1.

Chart 20

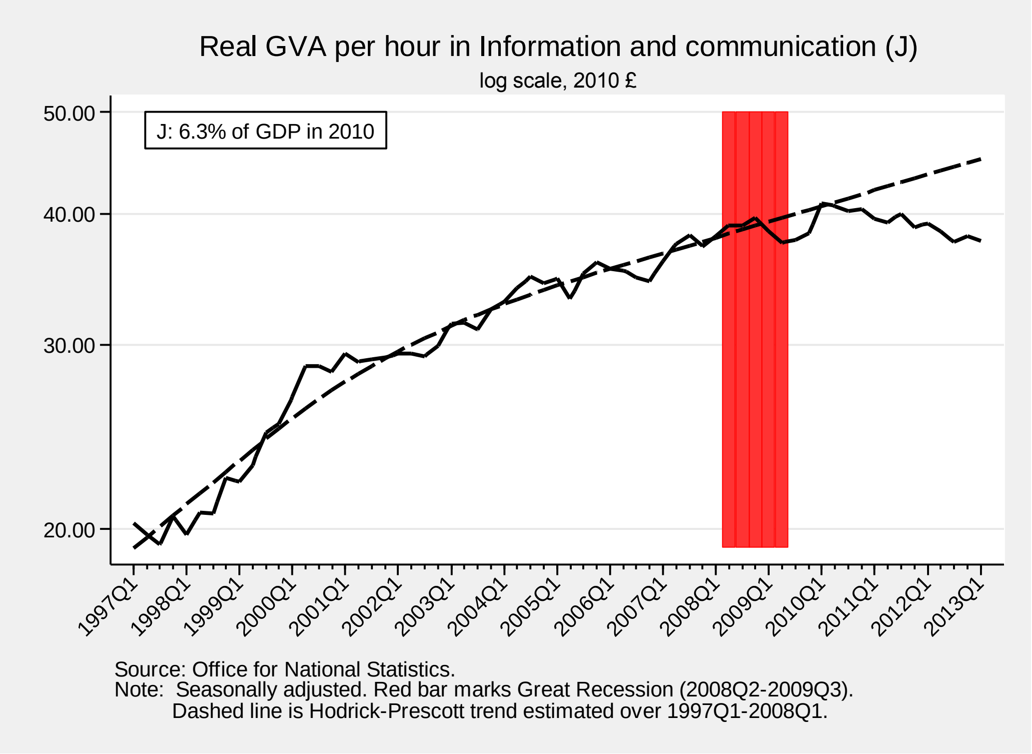


Chart 21

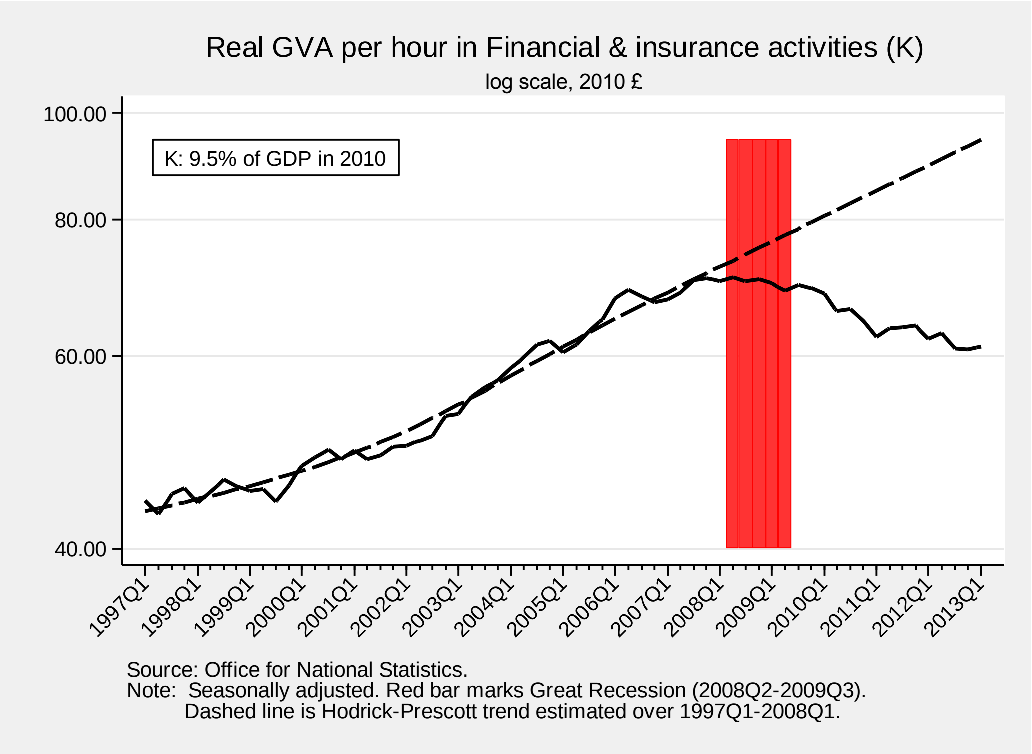


Chart 22

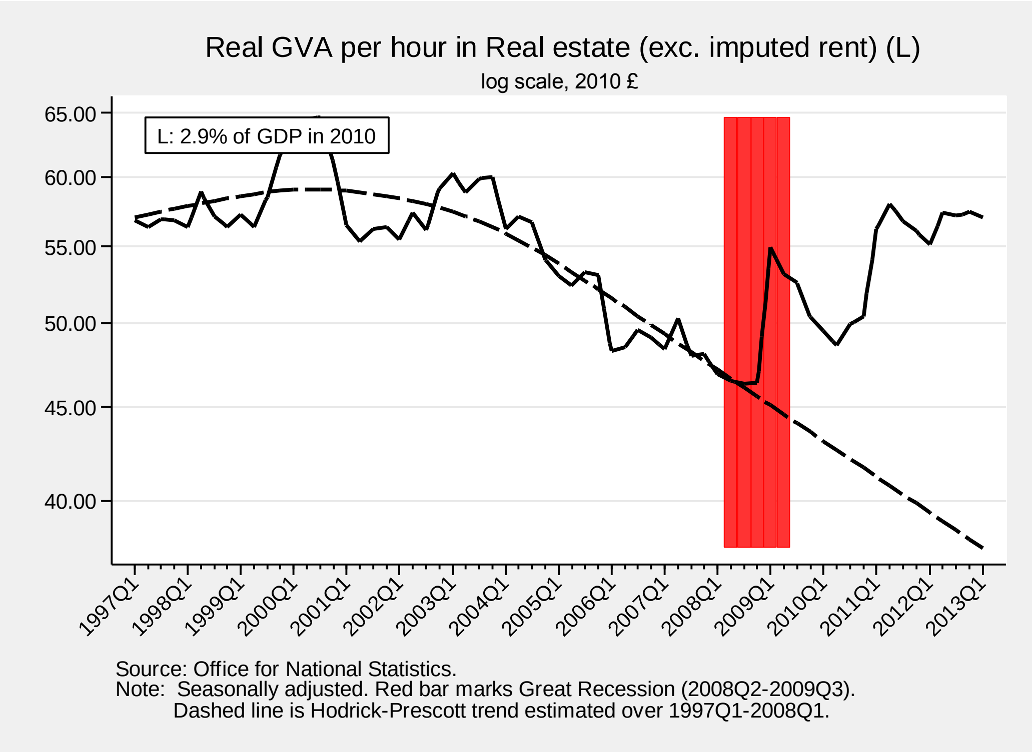


Chart 23

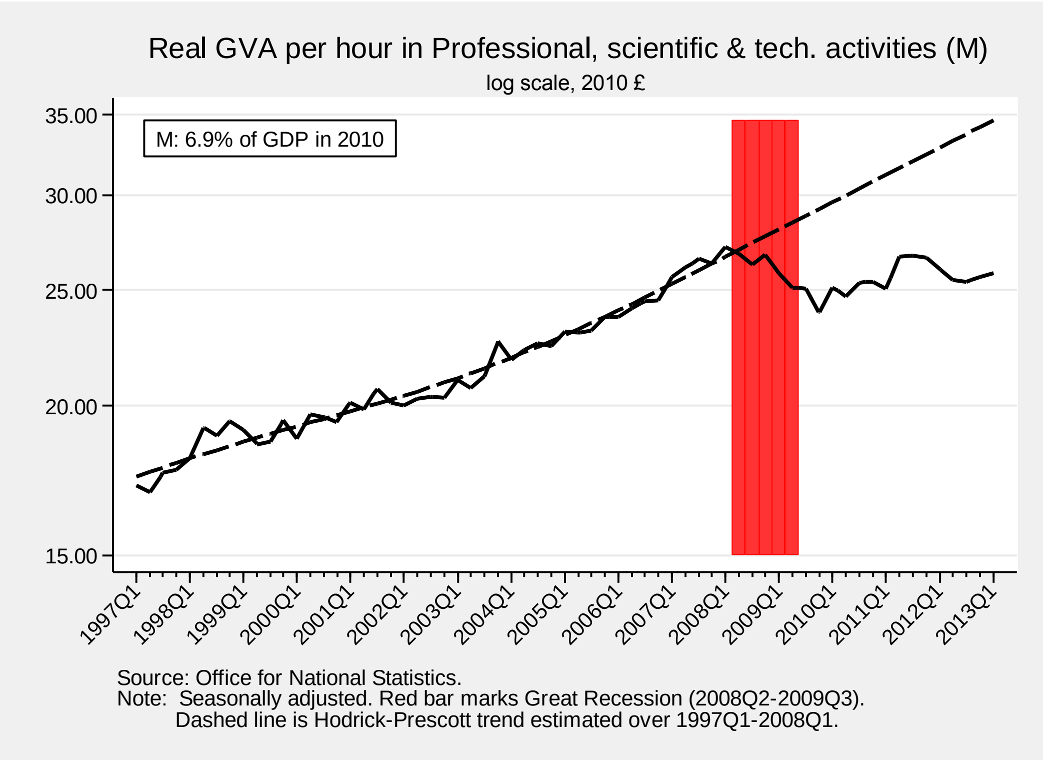


Chart 24

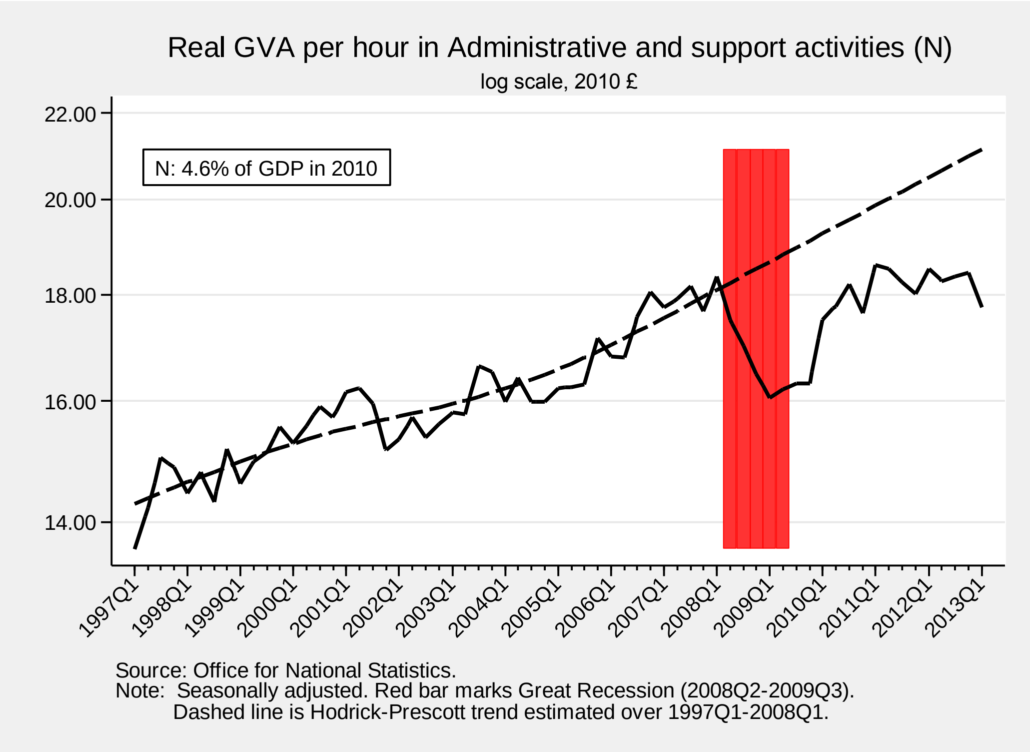


Chart 26

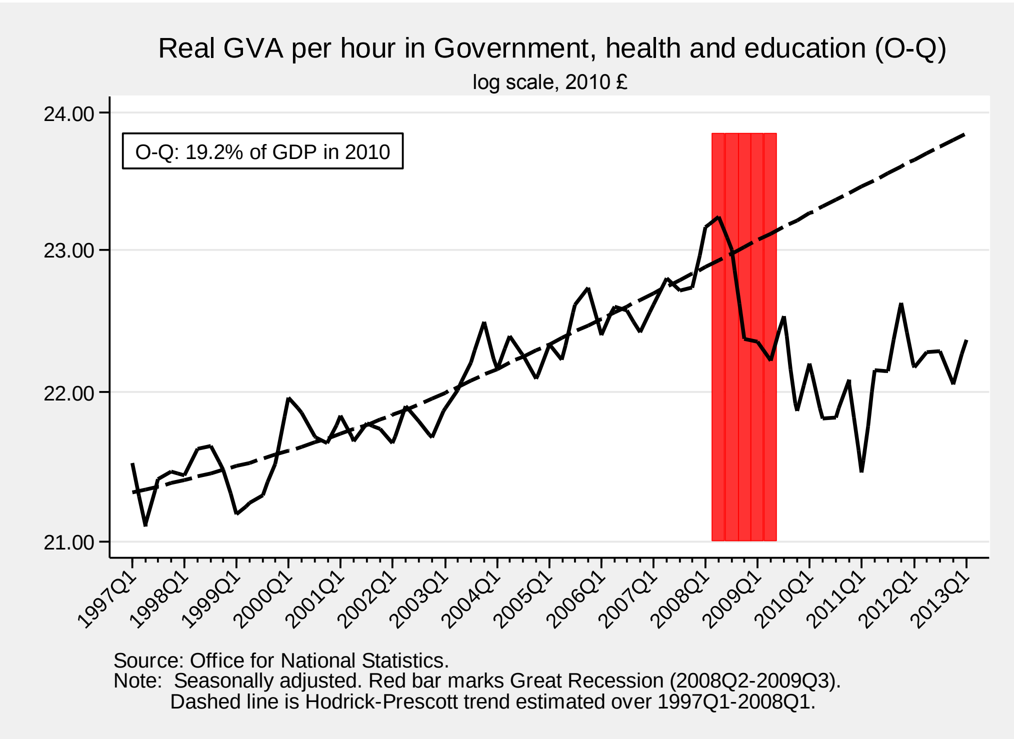


Chart 27

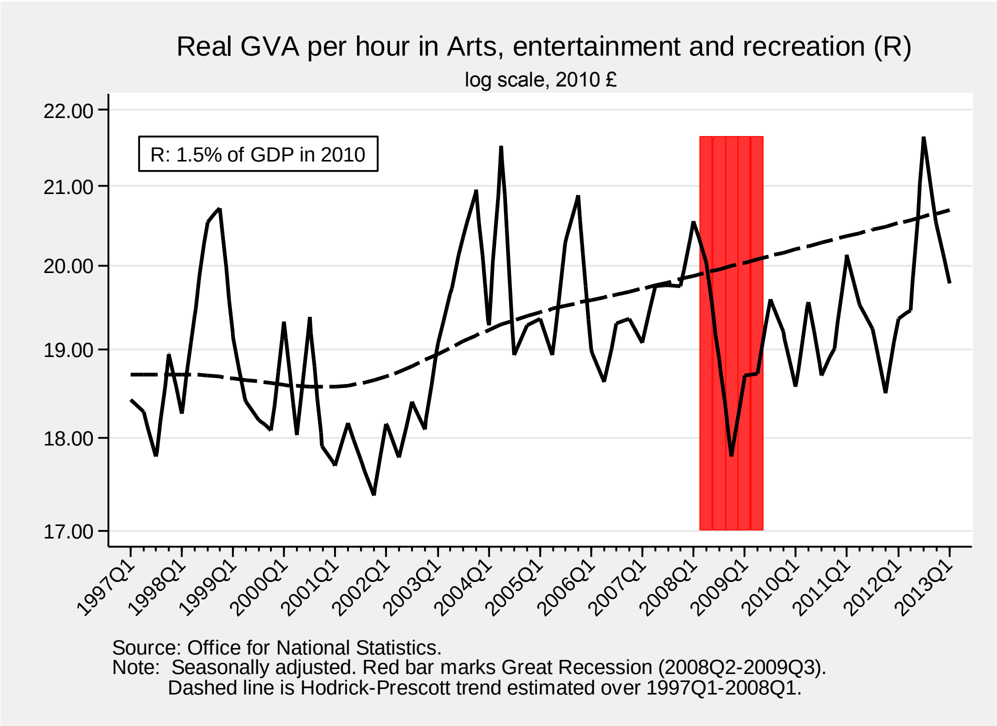


Chart 28

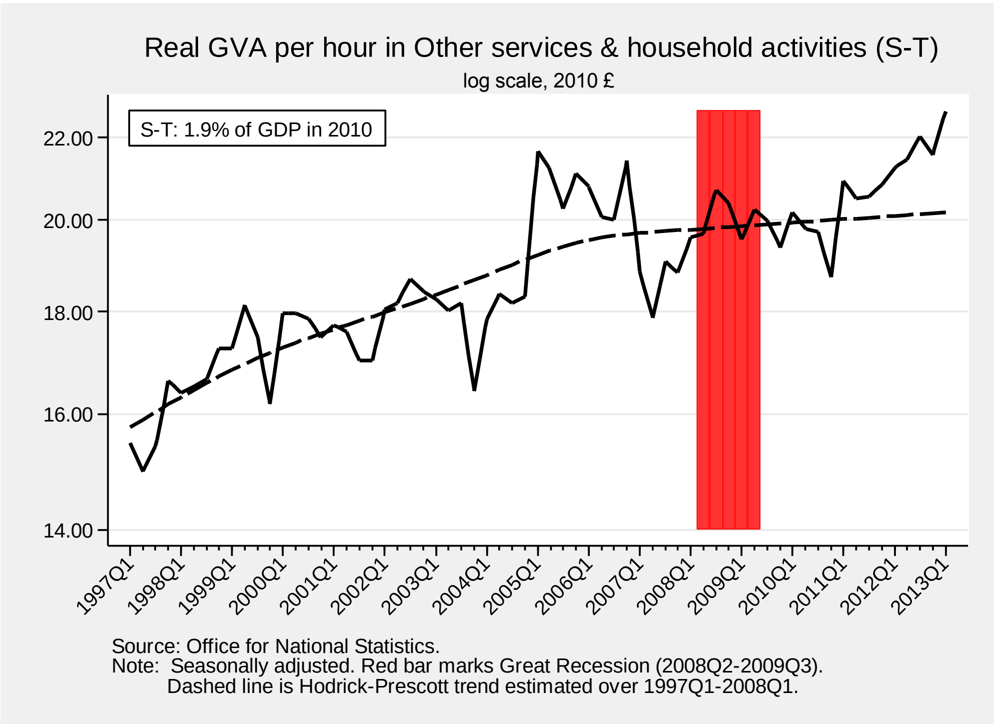


Chart 29

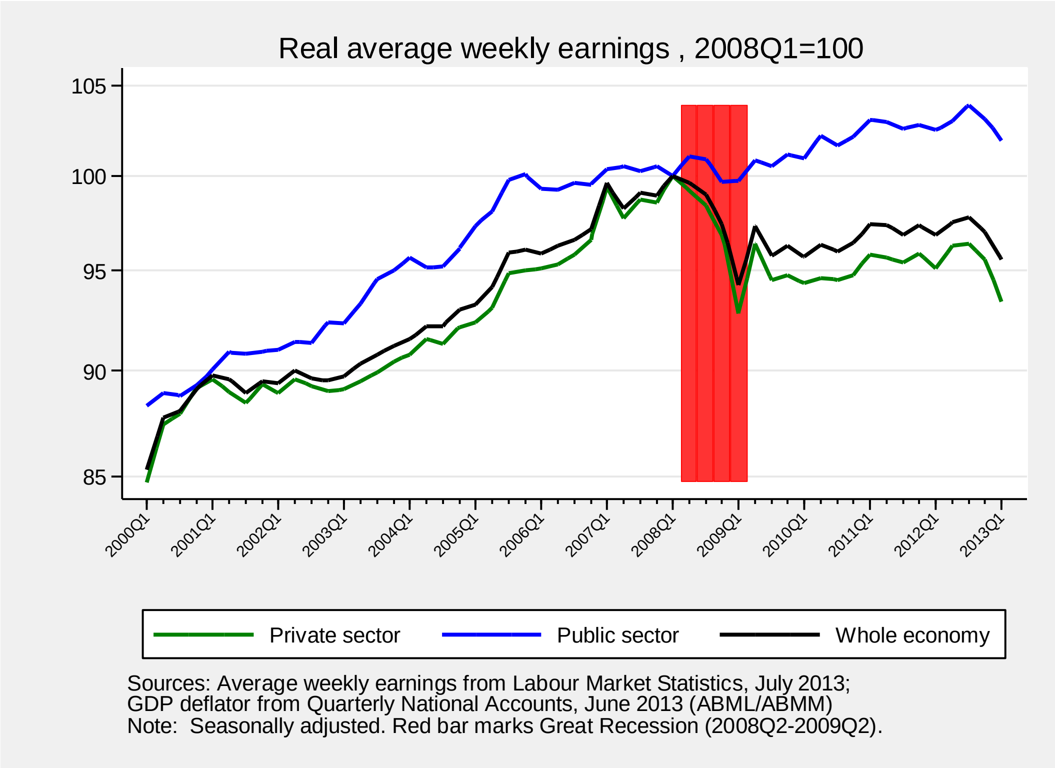

Real average weekly earnings , 2008Q1=100
105
100
95
90
85
2000Q1
2001Q1
2002Q1
2003Q1
2004Q1
2005Q1
2006Q1
2007Q1
2008Q1
2009Q1
2010Q1
2011Q1
2012Q1
2013Q1
Private sector
Public sector
Whole economy
Sources: Average weekly earnings from Labour Market Statistics, July 2013;
GDP deflator from Quarterly National Accounts, June 2013 (ABML/ABMM)
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q2).

Chart 30

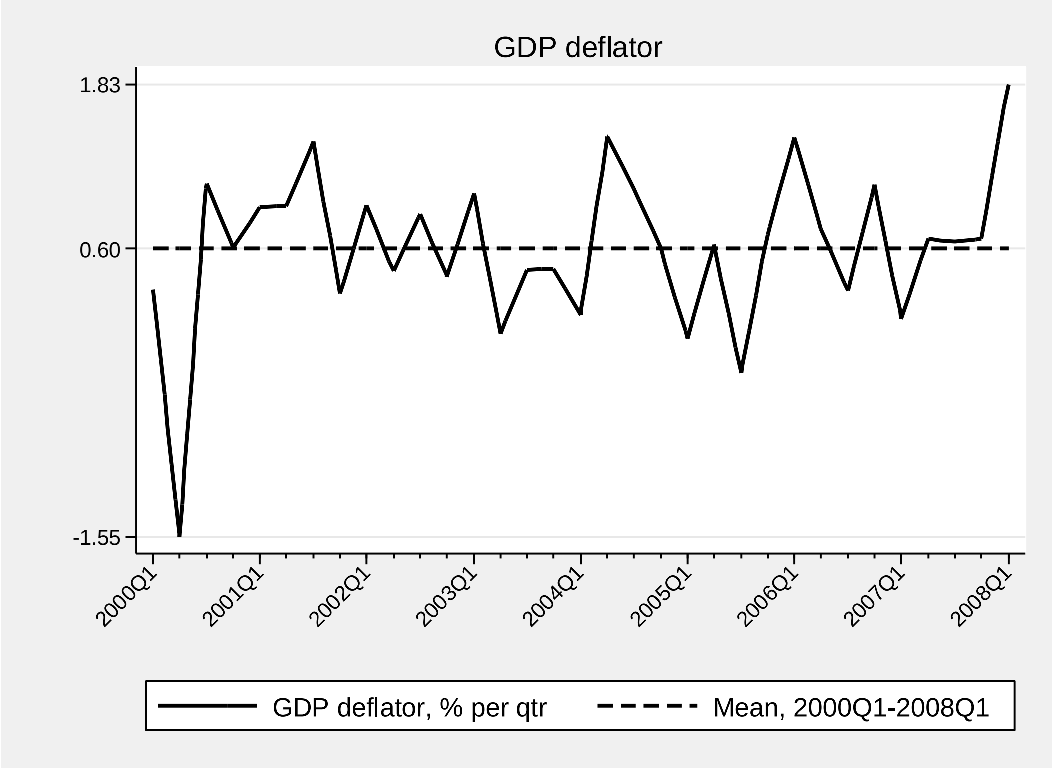


Chart 31

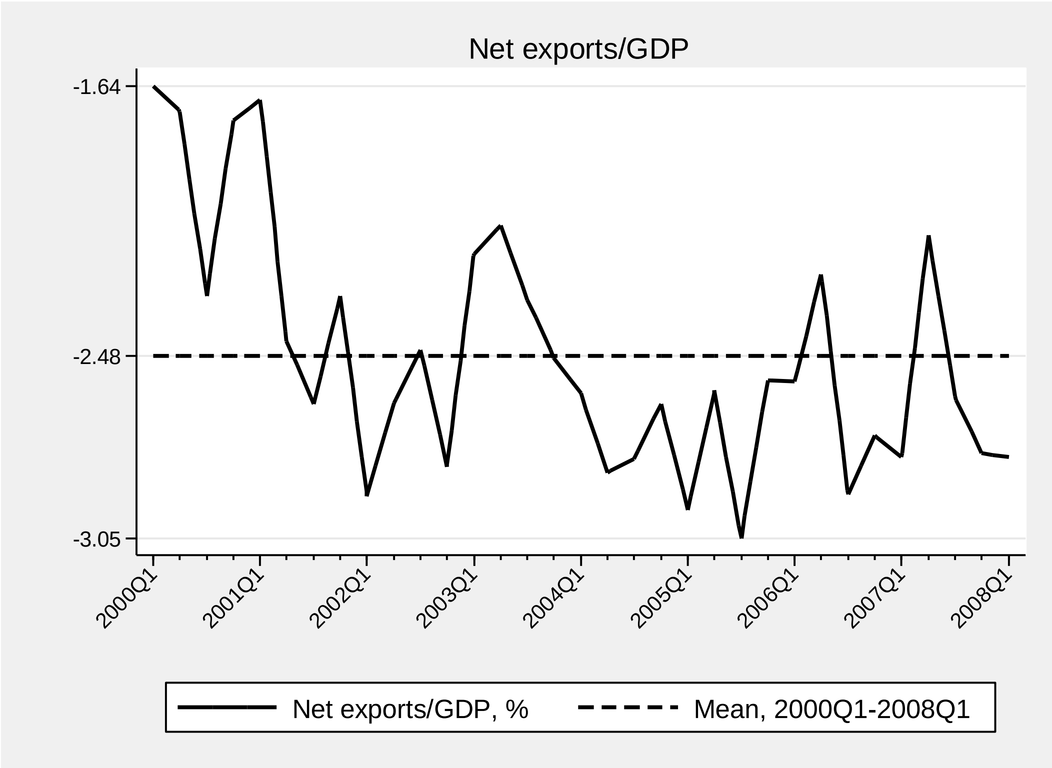


Chart 32

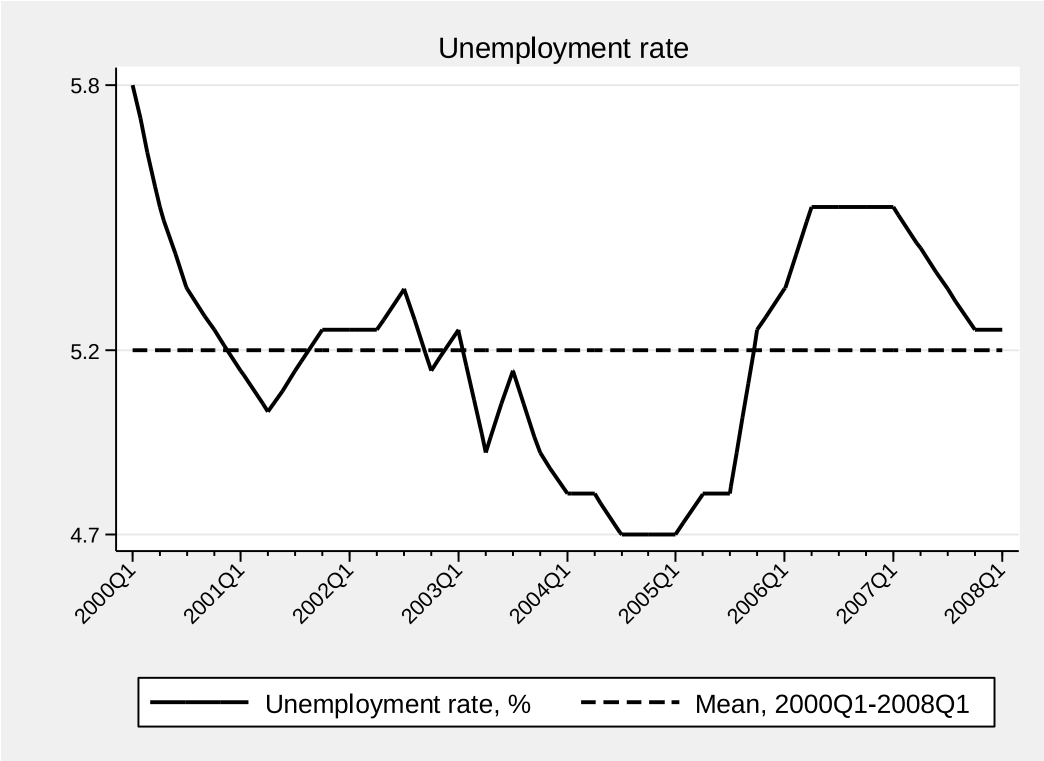


Chart 33

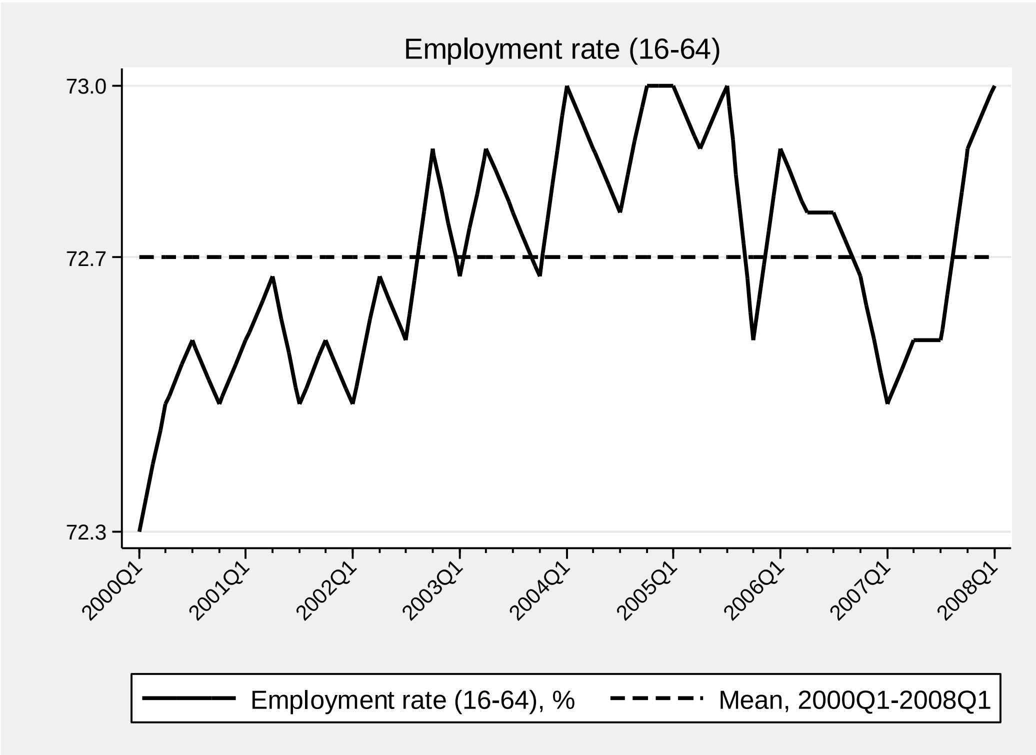
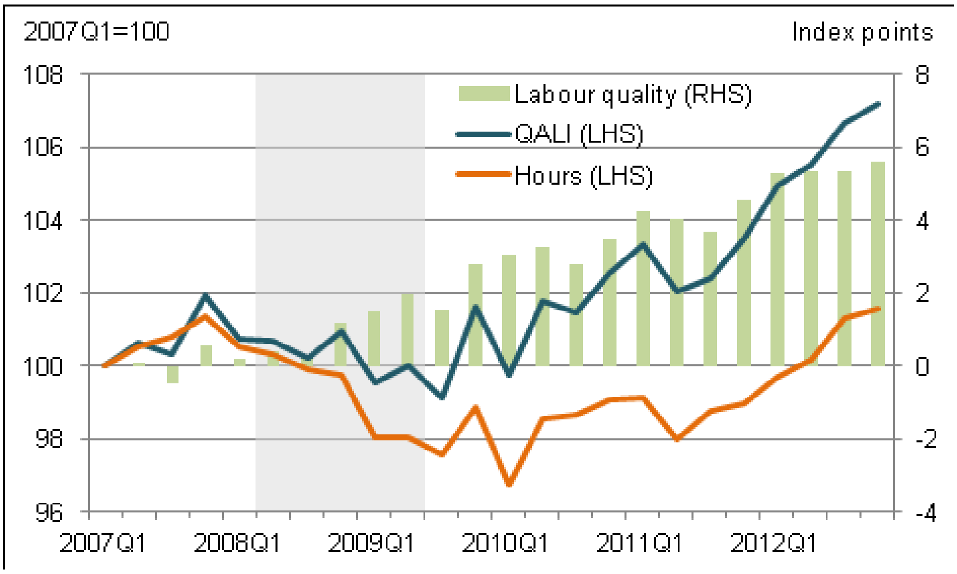
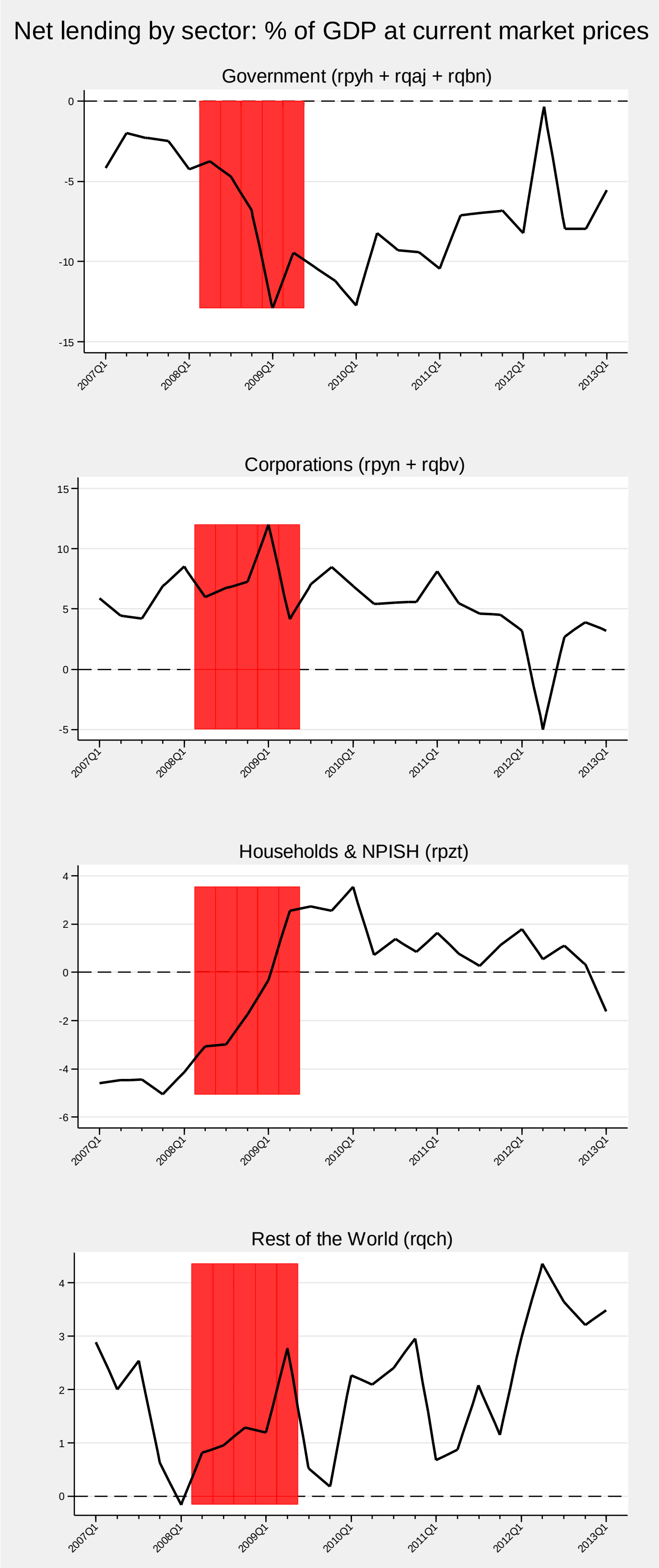


Chart 34
Quality-adjusted labour input (QALI) in whole economy



Source: Office for National Statistics (Franklin and Mistry, 2013).
Notes
1. Shaded region shows quarters of negative output growth
2. Underlying data rebased from 1993Q1

Chart 35



Source: ONS, Quarterly National Accounts, June 2013 (ONS ccid's in brackets).
Note: Seasonally adjusted. Red bar marks Great Recession (2008Q2-2009Q2).

Chart 36

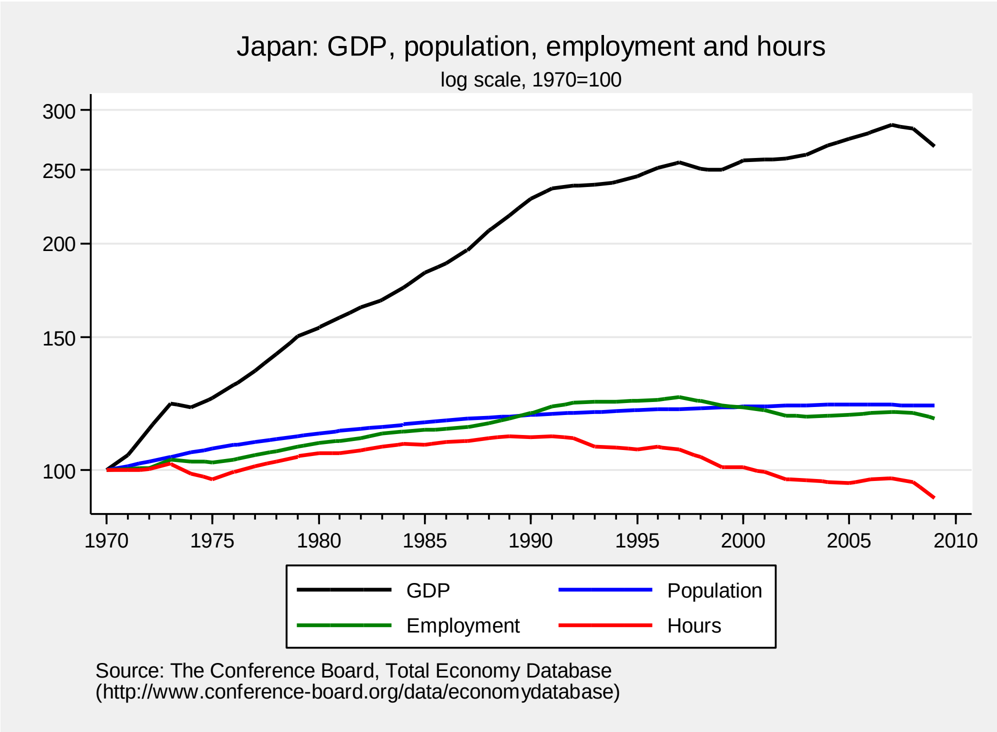


Chart 37

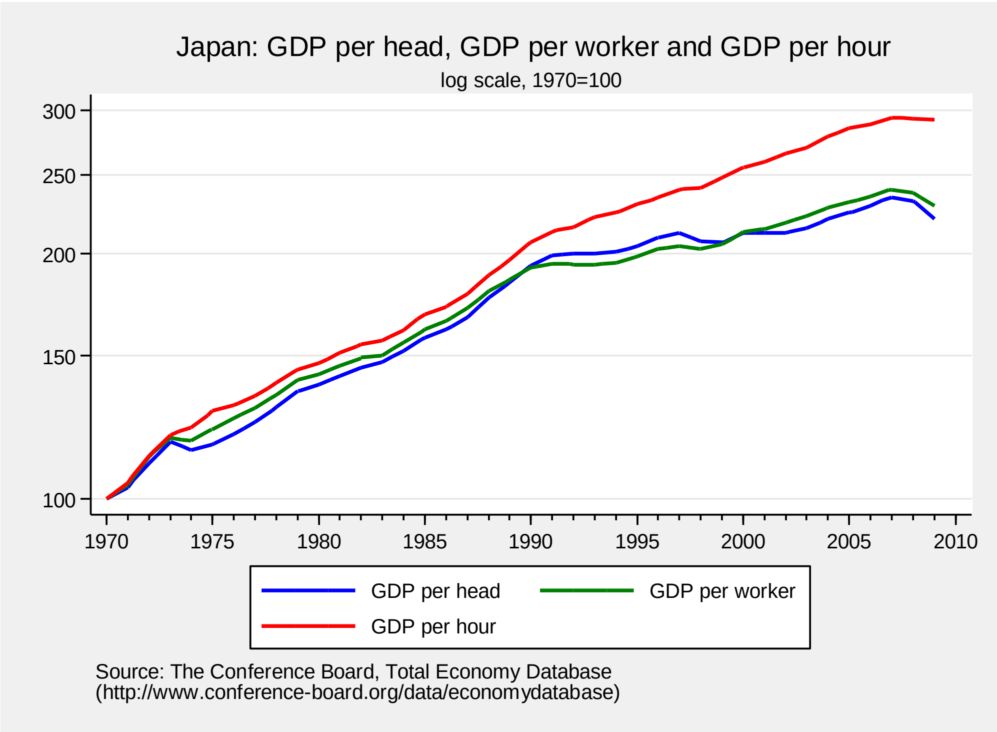


Chart 38

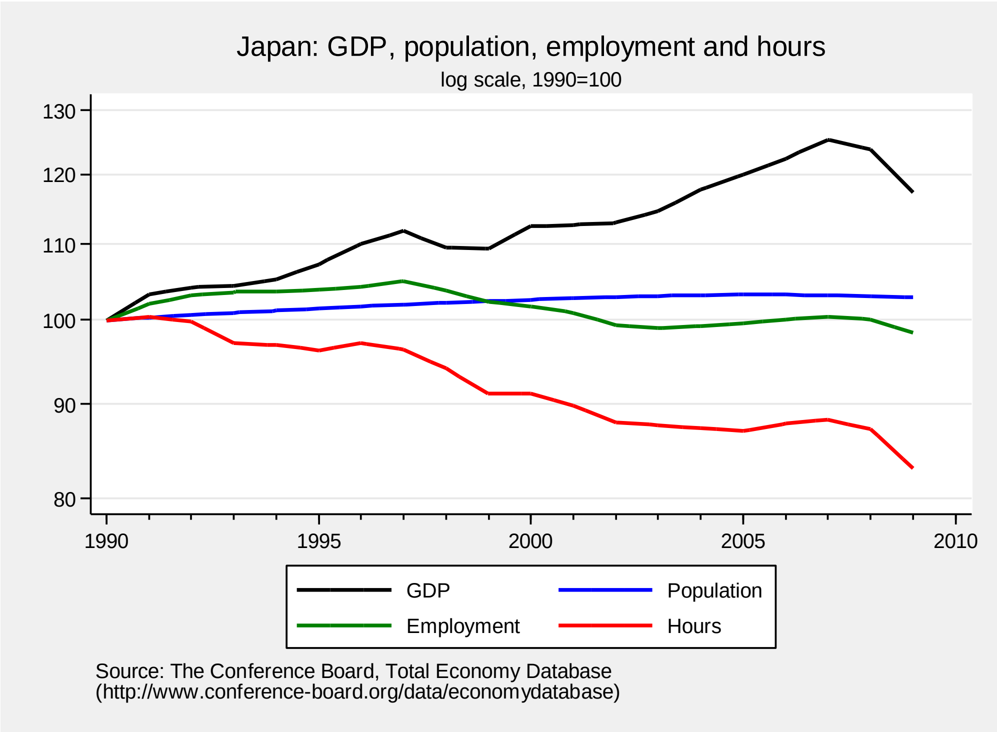
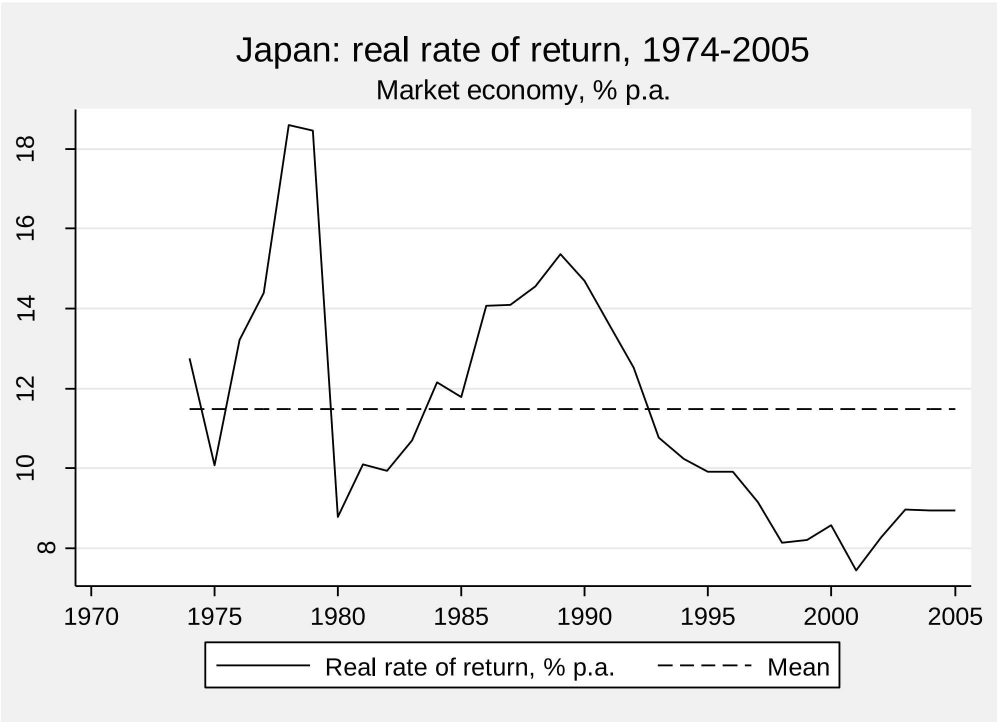


Chart 39



Source: Oulton and Rincon (2012), based on EU KLEMS database (November 2009 release, www.euklems.net).

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